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REPORT BY THE ENVIRONMENT POLICY COMMITTEE ON THE IMPLEMENTATION OF THE RECOMMENDATION OF THE COUNCIL ON RESOURCE PRODUCTIVITY [C(2008)40]

(Note by the Secretary-General)

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1. This document presents an assessment by the Environment Policy Committee (EPOC) on progress achieved in implementing the 2008 Recommendation of the Council on Resource Productivity [C(2008)40].

I. Introduction

2. The Recommendation of the Council on Resource Productivity [C(2008)40], reproduced, for ease of reference, in Appendix II to the present document, was adopted by the OECD Council on 28 March 2008 [C/M(2008)6/PROV, Item 76] and welcomed by Environment Ministers at their meeting on 28 April 2008.[1] The Recommendation responds to the particular interest in resource productivity and sustainable resource management expressed by countries and at international level. It provides a contribution by OECD Members, as a group, to international debates and initiatives concerning green growth, sustainable resource and materials management, resource efficiency and the circular economy. The term "*resource*" is understood to include natural resources (and the materials and products derived therefrom) whose extraction, processing, use and disposal are internationally significant, in both economic and environmental terms. The scope of the Recommendation is limited to minerals (metallic and non-metallic industrial minerals), and biomass. Energy resources (e.g. coal, oil, gas), water resources and fishery resources are excluded and are only covered to the extent that they are part of an integrated approach to the entire resource cycle.[2] The term "*resource productivity*" is 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). Energy efficiency is excluded, although it is recognised that energy efficiency and resource productivity are interrelated.[3]

3. The objective of the Recommendation is to support Members' efforts to improve the productivity of resources throughout the entire cycle of their use. This is with a view to reducing negative effects on the environment, preventing natural resource degradation and avoiding the loss of valuable materials contained in waste from the economy. The focus is on the environmental management of natural resources and materials.

4. The Recommendation applies to both (i) the **knowledge and analytical capacity** concerning material flows and resource productivity at national, international and global levels, including their economic and environmental implications; and (ii) the **policies and measures** that are needed to encourage environmentally effective and economically efficient uses of natural resources and materials to reduce associated negative environmental impacts.

5. In adopting the Recommendation, Council instructed EPOC to report "on progress achieved in implementing this Recommendation, within five years of its adoption."

6. In order to comply with this instruction, EPOC:

- Reviewed existing policies and practices that aim to improve resource productivity, with particular attention to sustainable materials management (SMM), elaborated common principles and policy guidelines on SMM, and prepared case studies on selected materials.

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1 It follows on an earlier Recommendation of the Council on Material Flows and Resource Productivity [C(2004)79] (adopted by Council in April 2004), whose objective is to improve information on material flows and to establish common measurement systems and indicators.

2 Definition in footnote 1 of C(2008)40.

3 Definition in footnote 2 of C(2008)40.

- Improved the measurement of material flows and resource productivity, in collaboration with international partners and research institutes. Particular attention was given to the refinement of material flow and resource productivity indicators and their inclusion in the OECD sets of environmental and green growth indicators, and to the expansion of the OECD database on material flows. A report bringing together information on material resources, productivity and the environment is being prepared (OECD 2014, forthcoming).
- Facilitated the exchange of experience and best practices through regular Working Party meetings, workshops and forum events. Some of these events included non-Member countries[4] or were targeted specifically at developing countries, such as the Global Forums on Sustainable Materials Management in October 2010 and on Extended Producer Responsibility in June 2014.
- Co-operated with the International Resource Panel established in 2007 and led by the United Nations Environment Programme (UNEP), by providing relevant information, knowledge and experiences of EPOC through the Secretariat's participation in the Panel's Steering Committee.

7. The progress report, set out in Appendix I to the present document, and its main conclusions build on:

- Information compiled from country contributions to the annual Round Table on Environmental Information held by the Working Party on Environmental Information (WPEI) which built on, and updated, the results of an earlier survey of material flow activities carried out in 2007[5].
- Information compiled from country contributions to the regular Round Tables held by the Working Party on Resource Productivity and Waste (WPRPW); a survey on SMM policies conducted in 2011[6], that updated an earlier survey carried out in 2007; and a survey of the global use of Extended Producer Responsibility schemes carried out in 2013.
- Replies from twenty-three Members[7] to a questionnaire on the implementation of the Recommendation [see document ENV/EPOC/WPRPW/WPEI(2014)1].

II. Assessment of progress made

8. The Recommendation has been in place for a relatively short time compared with the time required to develop the knowledge and information base on all of its provisions, as well as for policies to produce impacts on resource productivity. Nevertheless, progress has been achieved in a number of areas.

9. While global use of material resources continues to grow in line with global GDP, there are signs of decoupling of material consumption from economic growth in OECD countries, and an improvement in resource productivity. OECD economies today generate almost 30% more economic value with one tonne of raw materials than they did in 2000. Progress in resource productivity can be attributed to several factors: policy measures, technological change that led to improved efficiency, structural changes, including the rise of the service sector, and the substitution of resource intensive domestic production by imported goods.

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4 The following non-Member countries participated in one or several of these activities : China, Colombia, Costa-Rica, Egypt, India, Indonesia, South Africa, Malaysia, Philippines, Russia, Thailand, Uganda, Vietnam, Zambia.

5 OECD (2008), *Measuring material flows and resource productivity – Inventory of country activities*.

6 In 2011, 16 countries participated in the survey, including all G7 countries, and the EC.

7 Add the list of countries here from footnote 10: 14 EU member states (Austria, Belgium, Czech Republic, Germany, Spain, Estonia, Finland, France, Poland, Portugal, Netherlands, Slovenia, Slovak Republic and Sweden); Canada, Chile, Iceland, Japan, Korea, Norway, Switzerland, Turkey and the United States.

10. The trend of decoupling of material consumption from economic growth has also continued since 2008, even though much of it is linked to the slowing demand for materials as a result of the financial and economic crisis. Prior to the crisis, there were only a few examples of material consumption decreasing while economic growth increased (absolute decoupling), notably in Germany, Japan, and Netherlands, i.e. countries with high recycling and recovery rates and well-developed resource efficiency strategies. Since then, a majority of OECD countries display absolute decoupling, as material consumption across the membership decreased by 11%.[8] The annual per capita material consumption in OECD countries however remains high, at about 60% above the world average.

11. The countries that achieved absolute decoupling before 2008 used a range of policies to further the sustainable management of materials and to promote the 3Rs. A generally positive trend can be observed for municipal waste[9] , i.e. per capita municipal waste decreased by almost 4% over the past ten years in the OECD, and efforts to treat waste as a resource have started to pay off. Recycling rates (i.e., the share of materials recovered from waste) have been increasing for a large range of important materials, such as glass, steel, aluminium, paper and plastics reaching levels as high as 80% for some of them.

2.1 Progress with regard to the analysis of material flows and their environmental impacts

12. Since 2008, practical applications of material flow analysis have progressed. Almost all OECD Member countries carry out some activities in this area, though the status of the work, its characteristics and scope, purpose and policy use vary considerably. The production of internationally compatible material flow accounts has expanded as has the use of material flow indicators, including indicators on resource productivity, that parallel those describing labour productivity, and indicators that measure the decoupling of resource use from economic growth. In several countries these indicators are associated with targets and with policy plans and strategies. In the European Union, reporting on material flows has become mandatory under a regulation on environmental accounting adopted in 2011. This is supported by the adoption at UN level of the System of Environmental-Economic Accounting (SEEA) as an international standard. Japan has actively promoted the development of material flow cost accounting and its use by businesses and other organisations. In 2011, material flow (MF) cost accounting has been integrated into the family of International Standards Organisation (ISO) standards on environmental management (ISO 14051:2011).

13. Some countries give priority to studying flows of specific substances with potential negative impacts on the environment and human health, or to analysing priority resources, products or materials with the aim to make specific supply chains more sustainable. Steps have also been made towards estimating demand-based material flows, i.e. raw materials embodied in traded goods, so as to better understand environmental consequences of material resource use in a global context and the effects of domestic policies on resource productivity. Such measures parallel those measuring trade in value added and carbon embodied in trade. An international consensus on measurement methods does however not yet exist.

14. However, overall, progress in implementing the provisions of the Recommendation with regard to the analysis of material flows and their environmental impacts is insufficient. Most of these positive developments relate to macro-level accounts and indicators whose development started in the early 2000s. Information gaps and inconsistencies still limit the ability to track trends in resource productivity in many countries and at international level. Little progress has been made in analysing the environmental impacts and costs of material resource use and in developing related indicators; information on the quality and deterioration of natural resource stocks is insufficient and often not comparable. Important gaps include

[8] This can largely be attributed to the construction sector, which is both very material intensive and was particularly hard hit by the crisis.

[9] Municipal waste represents roughly 10% of total waste generation in most OECD countries.

disaggregated information on material resource use and productivity by industry, information on direct and indirect flows of raw materials associated with international trade, and flows of secondary (recycled) raw materials and waste. Gaps also remain as regards internationally compatible information on key materials or substances that are of particular economic or environmental importance.

2.2 Progress with regard to the policies concerning the improvement of resource productivity

15. Improving resource productivity is of increasing importance to many governments. Since 2008, an increasing number of countries have included resource productivity as a central objective in their green growth or sustainable development strategies or environmental plans, often in combination with energy efficiency. Many countries have established plans on sustainable production and consumption, integrated waste and materials management, including the 3Rs or circular economy approaches, stewardship programmes for materials and natural resources, and green public procurement policies.

16. The results of two surveys in 2007 and 2011[10] show that the concept of SMM developed by the OECD is also increasingly used by OECD Members. Half of the respondents now have a national SMM definition and policies that specifically address SMM. These policies address materials as well as product categories, and their scope has expanded significantly in recent years. The use of economic instruments to encourage SMM has also expanded, often in conjunction with waste management policies (e.g. landfill taxes, extended producer responsibility and incineration taxes). Other instruments in place include legally binding targets and performance standards, as well as voluntary initiatives, and information-based instruments, including product labelling.

17. However, the more comprehensive policy approaches have not readily resulted in effective implementation. Many OECD Members report that implementation is hampered by the broad scope of resource productivity issues that requires the involvement of many economic actors in different sectors and in different locations in the supply, use and disposal chain. Only a few countries have effective mechanisms to support policy coordination and coherence. Other obstacles include the lack of reliable data to effectively target policies and measures, and to monitor their effects, and the lack of awareness of the economic benefits and opportunities that improved resource productivity provides. Efforts to intensify cooperation with developing countries have been strengthened, such as through the Regional 3R Forum in Asia and the Pacific that is championed by Japan, as well as UNEP's International Resource Panel, where OECD is a member of the steering group.

2.3 Overall assessment

18. In preparation of the progress report, OECD Member countries were asked to assess the level of awareness, the degree of implementation, the usefulness and the continued relevance of the Recommendation of the Council on Resource Productivity. In most of the twenty-three countries that responded, the awareness of the issues and principles underlying the Recommendation is perceived to be high, while the awareness of the Recommendation itself is perceived to be more moderate. Despite a high number of initiatives and recent efforts, a majority of Members who responded do not see the Recommendation as fully implemented yet. Most OECD Members believe that the Recommendation has been useful in supporting national and international policy processes and debates, albeit not as a key driver, but rather as an important reference that legitimises these processes. EU members underline in particular its usefulness in a broader international context, but consider that EU policies and law have a greater influence on national policies. Respondents were unanimous about the continued relevance of the Recommendation as its implementation has only been partially achieved in most cases and given that key objectives and principles laid out there are still highly relevant and possibly even more so since the

[10] 16 Member countries plus the EU responded to this survey.

resource crisis in 2008/09 and rising concerns about resource security. Respondents do not see a strong need to update the Recommendation now, but indicate that this might become necessary in the future, in particular by broadening its scope to link its provisions more strongly to circular economy approaches, by including objectives and milestones, and by providing more operational guidance.

19. Monitoring data confirms that significant additional efforts are still needed in OECD Member countries to further improve the resource productivity of their economies. This includes further efforts to scale-up and improve existing **policy approaches**, and to make them more coherent and better integrated. There is broad recognition among Members that further progress can only be achieved through more integrated policy approaches that take account of the full life-cycle of materials and that are designed according to the principles of sustainable materials management. This includes policies that affect trade in certain types of waste and trade in raw materials. An example is extended producer responsibility, where the responsibility of producers for their products is extended to include the economy-wide (or social) costs of waste management. This instrument has seen a steep increase of its use across the OECD membership and beyond, but while these schemes are usually effective at generating finance to pay for waste management, they do not deliver sufficient incentives to encourage producers to develop more environmental product designs as had been expected. The development of further practical guidance on sustainable materials management policies and circular economy models, and the production of more and better data would help to support those efforts.

20. OECD Members will need to make additional efforts to strengthen the **information base for monitoring progress** in resource productivity. Improvements are needed in particular as regards knowledge and information on the environmental impacts and costs of resource use throughout the life-cycle of materials, including impacts from resources that have been traded. More in-depth analysis is needed of specific resources and materials, and their interactions. Examples include trade related resource flows and flows of secondary raw materials, the way they interact with commodity prices and recycling markets, and how they relate to natural resource stocks and to innovation. Other examples are critical raw materials and materials raising specific environmental concerns. Further progress in providing industry-level and material-specific information will be essential to identify opportunities for improved performance and efficiency gains in production and consumption processes along the supply chains and to support analytical work.

21. In conclusion, the Recommendation has been in place for a relatively short time, and not long enough to develop the scientific knowledge and information needed to implement its main provisions, and to implement effective policies. Such policies require consideration of the entire life-cycle of resources, involve a large number of stakeholders along the value chain in different sectors of the economy, and cut across multiple policy domains.

22. The review of the implementation of the Recommendation shows that the provisions of the Recommendation have not yet been fully implemented, but that they remain valid, and do not need revision at this point in time.

2.4 Further work

23. Given the ongoing policy relevance of the Recommendation, further work will be undertaken to support Member countries' efforts in the areas outlined in paragraphs 19-21, as follows:

- EPOC will continue to work on integrated life-cycle-oriented approaches to resource productivity, including policy instruments, institutional arrangements, and innovation. EPOC has also launched efforts to develop more operational guidance on sustainable materials management. This includes work on economic instruments, with a focus on extended producer responsibility systems, as well as a review of waste prevention policies, which is planned for 2015/16. Where

possible, synergies will be developed with the UNEP International Resource Panel and EPOC's project on Cost of Inaction and Resource Scarcity – Consequences for Long-term Economic Growth (CIRCLE).

- EPOC will also continue to further develop internationally harmonised material flow and resource productivity data and indicators (at macro level and for selected materials), and to monitor and report on the state of resources and resource productivity in OECD countries and beyond. This is done in collaboration with UNEP and its International Resource Panel, Eurostat and several research institutes. EPOC also works with the Committee on Statistics and Statistical Policy (CSSP) to support the implementation at international level of the SEEA; in cooperation with United Nations Statistics Division and the World Bank. Further analysis of material flows, raw material requirements and their economic, trade and environmental implications will be carried out as part of the Organisation's work on green growth.

24. Some of this work may result, at a later stage, in further guidance or best practices, especially in the area of sustainable materials management. It is therefore suggested to keep the implementation of the Council Recommendation on Resource Productivity under review and take stock of the situation again within six years.

25. This progress report has been prepared by the WPRPW and the WPEI. It was submitted for comments under written procedure to the WPRPW, the WPEI and EPOC on 30 September 2014 and subsequently revised. On 5 November 2014, EPOC approved the report [ENV/EPOC/WPRPW/WPEI(2014)2/REV1] under written procedure and agreed to its transmission to Council.

III. Proposed action

26. In the light of the preceding, the Secretary-General invites the Council to adopt the following draft conclusions:

THE COUNCIL

a) noted document C(2014)148 and the report set out in its Appendix I, and agreed to the declassification of this report;

b) invited the Environment Policy Committee to carry out further work to support the implementation of the Recommendation, as set out in paragraph 23 of C(2014)148.

c) invited the Environment Policy Committee to continue monitoring developments regarding the implementation of the Recommendation [C(2008)40] and report to Council by 2020.

APPENDIX I

REPORT BY THE ENVIRONMENT POLICY COMMITTEE ON THE IMPLEMENTATION OF THE RECOMMENDATION OF THE COUNCIL ON RESOURCE PRODUCTIVITY [C(2008)40]

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INTRODUCTION

1. The Recommendation of the Council on Resource Productivity [C(2008)40] (RP Recommendation) was adopted by the OECD Council on 28 March 2008 and welcomed by Environment Ministers at their meeting on 28 April 2008. The RP Recommendation responds to the particular interest in resource productivity and sustainable resource management expressed by countries and at international level. It also provides a contribution by OECD countries, as a group, to international debates and initiatives concerning green growth, sustainable resource and materials management, resource efficiency and the circular economy; and signals the political will and leadership of OECD countries in these areas. It follows on an earlier Recommendation on Material Flows and Resource Productivity, adopted by the OECD Council in April 2004.[1]

2. The Recommendation "**INSTRUCTS** the Environment Policy Committee to report to Council on progress achieved in implementing this Recommendation within five years of its adoption."

1. Policy background

3. Natural resources provide essential raw materials, water and other commodities to support economic activity, and are an important source of income and jobs. As part of broader ecosystems, they support the provision of ecosystem services –climate regulation, flood control, natural habitats, amenities, cultural services– that are necessary to develop man-made, human and social capital. The use of materials from natural resources in economic activities and the related production and consumption processes have many environmental, economic and social consequences that extend beyond the borders of individual countries or regions, and that affect future generations. They have consequences on:

- The rate of extraction and depletion of renewable and non-renewable natural resource stocks, and the extent of harvest and the reproduction capacity and natural productivity of renewable resource stocks.
- The environmental pressures associated with the extraction, processing, transport, use and disposal of materials (e.g. pollution, waste, habitat disruption); and their effects on environmental quality (e.g. air, climate, water, soil, biodiversity, landscape) and on ecosystem services and human health.
- International trade and market prices of raw materials and other goods, and the productivity and the competitiveness of the economy.

[1] Recommendation of the Council on Material Flows and Resource Productivity [C(2004)79]. The objective of this Recommendation is to improve information on material flows and to establish common measurement systems and indicators. It led to the development of harmonised guidance on how to measure material flows and resource productivity and how to develop related indicators taking account of country's special circumstances. See OECD (2008a), Measuring material flows and resource productivity – OECD guide. The main provisions of the 2004 Recommendation are covered in this report.

4. Improving resource productivity and ensuring that natural resources and materials are managed sustainably and used efficiently all way through the economy is thus important, not only from an environmental perspective but also from an economic and trade perspective.

- Improving resource productivity *helps reduce, in a cost-efficient way, the negative environmental impacts* associated with the production, use and end of life management of natural resources, and avoid situations where valuable materials contained in waste are disposed of and ultimately lost for the economy. This is important to ensure that the consumption of resources and their associated impacts do not exceed the carrying capacity of the environment, and to break the linkages between economic growth and resource use. Improved resource productivity will in many cases also lead to greater energy and water efficiency.
- Improving resource productivity also indirectly *reduces demand pressures on natural resources* in the context of the global economy. This is particularly important in a world where the prices of many natural resources are volatile and are rising fast, amid growing demands; and where there are often concerns about the long-term security of supply of these natural resources. Supply of natural resources is a legitimate strategic concern for governments and businesses alike. Efficient management of environmental and economic impacts associated with using these resources will increase their long-term availability (and quality) for everyone, including by reducing pressures on primary resource stocks.

5. The measures taken to improve resource efficiency and material productivity through technical change, innovation, and more effective management approaches, create in turn opportunities for investment, income and employment, and for new products and markets.

2. Objective and scope of the Recommendation

6. The objective of the RP Recommendation is to support Member countries' efforts to improve resource productivity considering the entire resource cycle, with a view to reducing negative effects on the environment and preventing natural resource degradation. It applies to the **policies and measures** that are needed now and in the future, and to the **knowledge and analytical capacity** that is needed to inform such policies and measures. The focus is on the environmental management of natural resources and materials.

7. The Recommendation outlines a broad vision on:

- How to improve knowledge and analytical capacity concerning material flows and resource productivity at national, international and global levels, including their economic and environmental implications, and how to disseminate knowledge by means of information.

  It recommends that Member countries (i) improve the scientific knowledge concerning the environmental impacts and costs of resource use, including from resources that have been imported; (ii) improve the data on material flows within and among countries and the associated environmental impacts; (iii) implement internationally compatible material flow accounts; and (iv) develop indicators that assess the efficiency of material resource use, including indicators on the availability, quality and deterioration of natural resource stocks; and indicators on the flows and environmental impacts of materials.

- How to encourage environmentally effective and economically efficient uses of natural resources and materials at all levels so as to reduce the negative environmental impacts associated with the use of natural resources, materials and products, and to avoid waste of resources, taking into account the diversity of countries as regards their geographical and socio-economic context and their endowment in natural resources.

It recommends that Member countries take appropriate actions that (i) promote integrated life-cycle-oriented approaches, such as 3R policies (Reduce, Reuse, and Recycle), sustainable materials management and sustainable manufacturing; (ii) promote the use of new technologies and innovations; (iii) encourage co-operation and sharing of best practices among enterprises; (iv) establish framework conditions that improve resource productivity through economic instruments; and (v) ensure that the policy measures taken are efficient in economic terms, effective in environmental terms and equitable in social terms.

8. To support countries' efforts, the Recommendation instructs the Environment Policy Committee to facilitate the exchange of experience and best practices; review existing policies and practices; elaborate common principles and policy guidelines on resource productivity and sustainable materials management (SMM); strengthen its capacity for material flow analysis at the international level; and develop and promote the use of material flow analysis, resource productivity indicators, and methods for assessing the environmental impacts of resource use.

Box 1. Definitions

For the purposes of the RP Recommendation:

- The term "*resource*" is understood to include natural resources (and the materials and products derived therefrom) whose extraction, processing, use and disposal are internationally-significant, in both economic and environmental terms. The scope of the Recommendation is limited to minerals (metallic and non-metallic industrial minerals), and biomass. Energy resources (e.g. coal, oil, gas), water resources and fishery resources are excluded and are only covered to the extent that they are part of an integrated approach to the entire resource cycle[2].
- The term "*resource productivity*" is 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). Energy efficiency is excluded, although it is recognised that energy efficiency and resource productivity are interrelated.[3]

It should be noted that the Recommendation covers both resources that are extracted and processed in the country and resources that are imported, and that the concepts of resource productivity and resource efficiency are largely identical in the way that they are used in this report.

Other useful terms:

- The term "*entire resource cycle*" is understood to refer to the entire life cycle of materials and the products that embody them, from natural resource extraction, manufacturing, use and eventual disposal, including re-use, recovery, recycling, re-manufacturing, and end of life management.
- *The 3Rs (Reduce, Re-use, Recycle)* form part of the waste hierarchy and encourage the prioritisation of waste reduction ahead of the re-use and recycling of materials, to the extent that this is economically feasible. *3R and circular economy initiatives* aim at closing materials loops and extending the lifespan of materials through longer use, reuse and remanufacturing, and the increased use of secondary raw materials. These initiatives also aim at material substitution: using materials with lower environmental impact, and replacing the environmentally most damaging materials.

2 Definition in footnote 1 of C(2008)40.

3 Definition in footnote 2 of C(2008)40.

3. Activities carried out by the OECD to support the implementation of the Recommendation

9. In order to support the implementation of the Recommendation and to provide a regular assessment of progress made, the OECD and its Environment Policy Committee (EPOC):

- Facilitated the exchange of experience and best practices through regular Working Party meetings, workshops and other events, including a Green Growth and Sustainable Development Forum on 'Encouraging the Efficient and Sustainable Use of Natural Resources' (Paris, 2012), a Global Forum on Environment on "SMM" (Mechelen, 2010) and a Global Forum on "Promoting SMM through Extended Producer Responsibility" (Tokyo, 2014).
- Reviewed existing policies and practices that aim at improving RP, giving particular attention to sustainable materials management (SMM), elaborated common principles and policy guidelines on SMM, and prepared case studies on selected materials (critical metals, aluminium, plastics, wood fibres, construction materials).
- Carried out a survey on progress made with SMM across Members and non-members in 2011, and monitored developments through the regular round tables held by the WPRPW.
- Carried out a survey on Extended producer Responsibility (EPR) schemes in 2013.
- Monitored developments in material flow accounting and resource productivity indicators through the annual Round Table on Environmental Information held by the WPEI.
- Improved the measurement of material flows and resource productivity. Particular attention was given to the refinement of material flow and resource productivity indicators and their inclusion in the OECD sets of environmental and green growth indicators, and to the expansion of the OECD database on material flows. This is done in collaboration with UNEP and its International Resource Panel, Eurostat and several research institutes. A report bringing together facts and figures concerning material resources, productivity and the environment has been prepared (OECD 2014b, forthcoming).
- Co-operated with the International Resource Panel established in 2007 and led by UNEP, by providing relevant information, knowledge and experiences of EPOC through the Secretariat's participation in the Panel's Steering Committee.

10. The OECD further supported the implementation of the Recommendation through its work on Sustainable Manufacturing carried out under the Committee on Industry, Innovation and Entrepreneurship (CIIE). A Sustainable Manufacturing Toolkit was designed to help businesses around the world, particularly supply chain firms and small and medium-sized enterprises (SMEs), develop a more viable, socially responsible business approach and make the most of green growth opportunities. It provides a set of 18 internationally applicable, common and comparable key performance indicators to measure and improve the environmental performance of manufacturing facilities (OECD 2012c).

I. KEY DEVELOPMENTS IN COUNTRIES AND AT INTERNATIONAL LEVEL

1. Developments at international level

11. Since the early 2000s, there have been a growing number of **initiatives at the international level** that focus on resource productivity, sustainable resource use and materials management and the circular economy, and that encourage international cooperation in these areas. Sustainable resource use and resource productivity have been addressed by the Heads of State and Government of G8 countries, and are actively promoted by the OECD, UNEP and the European Commission.

- Heads of State and Government of **G8 countries** paid specific attention to these issues at their summits in 2003, 2004, 2006, and 2008. At their 2004 summit (Sea Island, United States), they endorsed the **3R initiative** (Reduce, Reuse, and Recycle). They asked OECD to contribute to a better understanding of material flows and resource productivity and to play a supportive role. At their 2008 meeting (Kobe, Japan), G8 Environment Ministers' adopted the **3R Action Plan** and requested the OECD to follow up on the progress of work related to resource productivity[4].
- UNEP established in 2007 an International Panel on Sustainable Resource Management (**International Resource Panel**), to provide independent scientific assessment on the sustainable use of natural resources and of their environmental impacts over the full life cycle. First results from its work were published in 2010.
- The **European Commission** adopted in 2005 an EU Thematic strategy on the sustainable use of natural resources, that has been complemented with a strategy on the prevention and recycling of waste, integrated product policies (IPP), an Environmental Technology Action plan, and a Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan (2008). In addition, the EU Raw Materials Initiative (November 2008) and Strategy (February 2011) set out measures to secure access to non-energy raw materials for the EU, to boost resource efficiency and promote recycling including through improvements in recycling markets, in waste treatment, in statistics on waste and materials flows.

  These objectives are also part of the EU 2020 Flagship Initiative on Resource Efficiency (announced in January 2011). The initiative provides a long-term framework for actions in many policy areas aiming at increasing certainty for investment and innovation and ensuring that all relevant policies factor in resource efficiency in a balanced manner. It encompasses a RE Roadmap and a set RE indicators whose implementation is supported by the European Resource Efficiency Platform.

  The EU has also developed criteria to distinguish secondary raw materials from waste so as to create greater legal certainty and a level playing field for the recycling sector, and works towards establishing a common market for "green products". A communication from the Commission "Towards a circular economy: a zero waste programme for Europe" was released in July 2014.

[4] The OECD provided an interim report at the 2011 G8 meeting: *Resource Productivity in the G8 and OECD: A Report in the Framework of the Kobe 3R Action Plan.* www.oecd.org/document/14/0,3746,en_2649_34395_47926478_1_1_1_1,00.html.

12. These initiatives are supported by international efforts that promote good **governance in the raw materials sector** and aim at making the management of natural resource rents more transparent (e.g. the Extractive Industries Transparency Initiative, and the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas); and by international efforts that promote sustainable consumption and production (SCP) under the UN Commission on Sustainable Development.

13. Improving resource productivity is also a central element in efforts to **establish a green economy and move towards green growth**. The OECD issued a Declaration on Green Growth [C/MIN(2009)5/ADD1/FINAL] in 2009 and released a Green Growth Strategy at the 2011 OECD Ministerial Council Meeting. The strategy outlines a policy framework that helps countries foster economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which well-being relies. It includes the policy packages needed to remove barriers and correct market failures and distortions to green growth, as well as a conceptual framework and a set of indicators to monitor progress. Progress is monitored along four main objectives: establishing a low carbon, resource efficient economy; maintaining the natural asset base; improving people's quality of life; implementing appropriate policy measures and realising the economic opportunities that green growth provides. (OECD 2011c; OECD 2014c).

14. Several other international bodies have embarked on work on green growth. The United Nations Environment Program (UNEP) launched its Green Economy Initiative in late 2008, including a framework for assessing progress. To achieve synergies at international level, the OECD works together with the Global Green Growth Institute, UNEP and the World Bank within the framework of the Green Growth Knowledge Platform (GGKP).

2. Developments in countries

15. Improving resource productivity is of increasing importance to many governments. Many countries have included resource productivity and efficiency issues in their sustainable development strategies, green growth strategies or environmental plans, have established programmes on sustainable production and consumption, sustainable manufacturing, stewardship programmes for raw materials and natural resources, integrated waste and materials management policies such as the 3Rs or circular economy approaches, and green public procurement policies. In several countries, policies to improve resource productivity are interwoven with energy efficiency policies. Many have set national targets for waste management focusing on end-of-life management and recycling. Some have set targets for material productivity and sustainable use of natural resources. Many initiatives are taken in Europe, stimulated by the policies, regulations and action plans of the European Union. This encompasses national strategies or action plans on resource efficiency and on raw materials, as well as waste management plans and targets.

16. Examples of relevant developments include:

- The *Fundamental Plan for Establishing a Sound Material-Cycle Society*, adopted by Japan that includes quantitative time-bound targets for resource productivity.
- The *Raw Materials Strategy* and the *Resource Efficiency Action Plan* in Austria.
- The *Raw Materials Strategy* and the *Resource Efficiency programme* (ProgRess) in Germany.
- The *circular economy roadmap* in France.
- the Netherlands' *National Programme on Natural Resources* that brings together all related policies and that proposes that the Netherlands takes responsibility for the pressures put on ecosystems worldwide by its use of natural resources; and the Netherlands *Waste to Resource*

programme that stimulates the transition to a circular economy and that contains eight operational objectives in the sequence of the value chain (building upon the Netherlands Waste Prevention Programme);

- Sweden's Waste Plan *From waste management to resource efficiency*.
- the United Kingdom *Resource Security Action Plan*.
- Switzerland's *Green Economy Action Plan* that promotes a more efficient and sustainable use of natural resources, and aims at making consumption more environmentally friendly and at strengthening the circular economy.

17. Several countries work in partnership with industry to move towards more sustainable use of natural resources and raw materials, reduce the amounts of waste that go to final disposal, and establish new more circular business models. Examples include:

- The *Resource efficiency network* set up by the German Ministry of the Environment that pools knowledge, information and good practices concerning resource efficiency and brings together actors from policy making, business associations, trade unions and society, including small and medium sized enterprises (SMEs).
- The *Material-efficiency Centre* in Finland.
- The strategic committees of the *French National Industry Council* that work on identifying ways to establish a circular economy.
- The Flemish Reference Centre on the Circular Economy established in 2013 to assist SMEs.
- The United States *Sustainable Manufacturing Initiative* (SMI) and Public-Private Dialogue launched by the Department of Commerce to support United States companies in their sustainable manufacturing efforts. The initiative aims to identify industry's most pressing sustainable manufacturing challenges and to coordinate public and private sector efforts to address these challenges.

Definitions

Sustainable manufacturing can be defined as *the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound*. (United States Department of Commerce).

18. While differing in their level of ambition and their specific focus, these programmes and policies all share:

- the need to move towards policies and measures that build on an integrated approach to natural resource and materials management over the full resource cycle;
- the need for greater efficiency in the way natural resources and materials are used in the economy;
- the recognition that a life cycle approach is needed to maximise the net benefits from natural resource and materials use and minimise negative impacts on the environment.

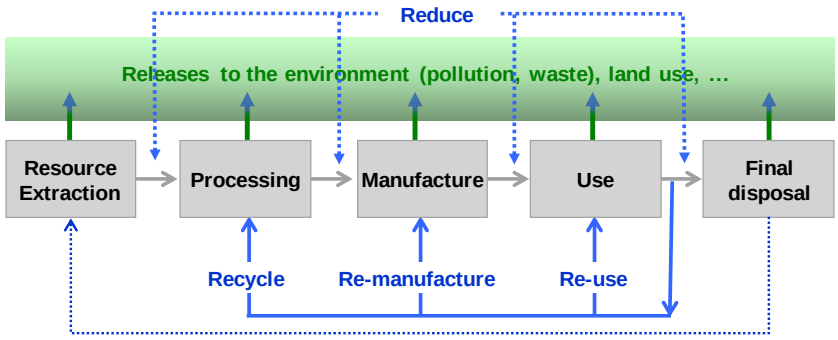
Several of these initiatives call for moving away from the traditional linear economic and business models towards circular models and a green economy.

3. Developments in the business sector

19. Many businesses address RP issues by establishing stewardship programmes for materials and products, investing in R&D and using innovation and advanced technologies to increase materials and energy efficiency, enhancing environmental management, promoting eco-design and coherent materials supply and use systems along the supply chain, including sustainable sourcing of raw materials. "Design-for-Environment" targets are triggering companies to re-design their products to reduce material use and toxic inputs, and to make products more recyclable. And interest in new "circular" business models and system innovation that encourage resource efficiency is increasing. These initiatives are driven by concerns about reducing costs, but also by consumer demand for greener management of materials.

20. Initiatives in the field of corporate performance reporting and accounting that integrate natural resource and materials use are also expanding. The European Commission recently created a common legal basis for the disclosure of non-financial information by large companies (April 2014).

Figure 1 The commercial material cycle, resource productivity and the 3Rs*: closing the loop



The **environmental consequences** of the use of natural resources and materials occur at different stages of the resource cycle and affect the quantity and quality of natural resource stocks and the quality of ecosystems and environmental media. The type and intensity of these consequences depend on the kind and amounts of natural resources and materials used, the way these resources are used and managed, and the type and location of the natural environment from where they originate.

✶**3R and circular economy initiatives** aim at closing materials loops and extending the lifespan of materials through longer use, reuse and remanufacturing, and the increased use of secondary raw materials.

These initiatives also aim at material substitution: using materials with lower environmental impact, and replacing the environmentally most damaging materials.

Source: OECD (2008a), Measuring material flows and resource productivity: OECD Guide; OECD (2014b), Material resources, productivity and the environment (forthcoming).

II. KEY TRENDS IN RESOURCE PRODUCTIVITY

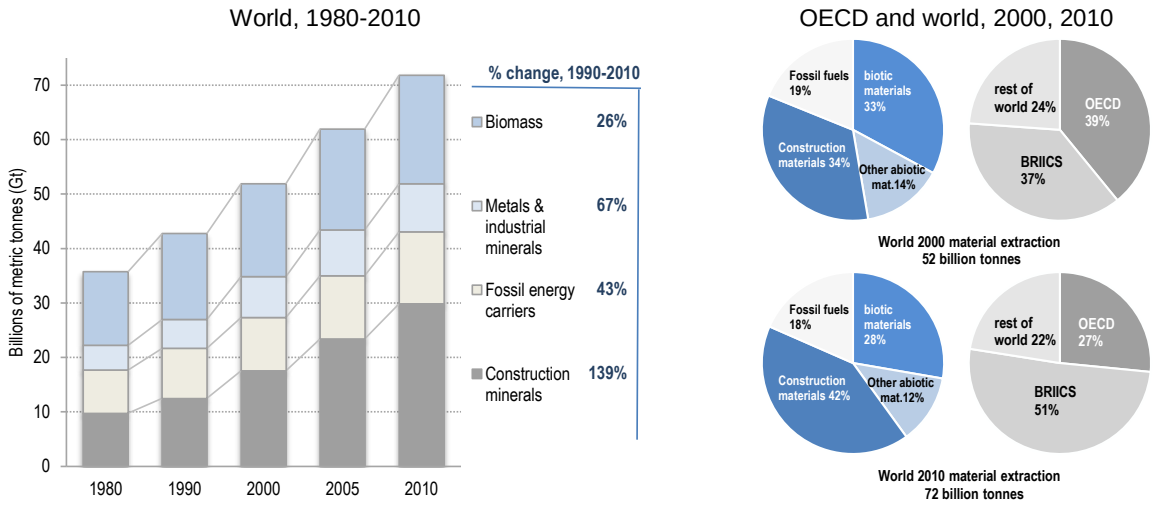
1. Trends in global material demands and resource extraction

21. The last decades have witnessed unprecedented growth in demands for raw materials worldwide, driven in particular by the rapid industrialisation of emerging economies and continued high levels of material consumption in developed countries. The amount of materials extracted, harvested and consumed worldwide increased by over 60% since 1990; it reached nearly 72 billion metric tonnes (Gt) in 2010, and is projected to reach 100 Gt by 2030.[5]

[5] Projection by Wuppertal Institute based on business as usual scenario.

22. Construction materials, fossil fuels, and biomass for food and feed, together represent more than 80% of total global extraction. In spite of fluctuations in the rate of material extraction in accordance with economic cycles, increased demand in emerging economies and continued high levels of consumption in OECD countries accelerated the trends over the 2000s. At the same time, international commodity markets have expanded, with increasing international trade flows, and increasing mobility of production factors. This has been accompanied by increases in, and volatility of, commodity prices, and by growing competition for selected raw materials.

Figure 2. Global extraction of material resources, world and world regions



Source: SERI and Dittrich, M. (2014). Global Material Flow Database. 2014 Version. Available at www.materialflows.net. OECD (2013). "Material resources", *OECD Environment Statistics* (database).

23. Resource extraction grew however more slowly in OECD countries than worldwide, mainly due to the rapid development of emerging economies and changing trade patterns. This was further exacerbated in recent years due to the 2008 financial crisis that led to a reduction in industrial output and in construction activities in many OECD countries. Today OECD countries account for:

- slightly less than half of the global economy in terms of GDP compared to about 60% in 2005;
- less than a third (27%) of all material resources consumed worldwide compared to 33% in 2005 and 43% in 1990.

24. These developments affect the ways in which natural resources are supplied to the economy. As production and consumption have become displaced with the changing geography of demand and supply and with increasingly complex and globalised value chains, questions arise about risks of disruptions in materials supply and about the geographical distribution of the environmental burden associated with the extraction and use of material resources.

Definitions

Decoupling is breaking the link between "environmental bads" and "economic goods". Absolute decoupling occurs when environmental degradation is decreasing while the economy is growing. Decoupling is relative when environmental degradation is growing, but at a slower rate than the economy. In the absence of reliable data on environmental degradation, decoupling is measured by relating environmental pressures such as resource extraction or pollutant discharges to economic growth.

Domestic material productivity relates economic output (in monetary terms) to natural resource or material inputs. Here it is calculated as the ratio of GDP per unit of domestic material consumption. It represents the economic value that is generated by using a given amount of natural resources or materials and goods.

Indirect material flows take into account the life-cycle dimension of the production and supply chain. They include the materials that are needed up-stream for the production of a product, but that are not physically embodied in the product itself, i.e. the primary raw materials extracted from natural resources or harvested, as well as mining overburden, unused harvest residues, process residues and wastes. Reliable estimates for indirect flows are not yet available.

Source: OECD (2008a), Measuring material flows and resource productivity: OECD Guide; OECD (2002), Indicators to measure decoupling of environmental pressure from economic growth, SG/SD(2002)1/FINAL.

2. Trends in material consumption and resource productivity

25. Material consumption[6] in OECD countries grew by 12% during the 1990s, reached about 23 Gt per year in the mid-2000s, and then decreased to 21 Gt in the late 2000s. Per capita material consumption in OECD countries remains high at about 17 tonnes per year; this is about 60% higher than the world average.

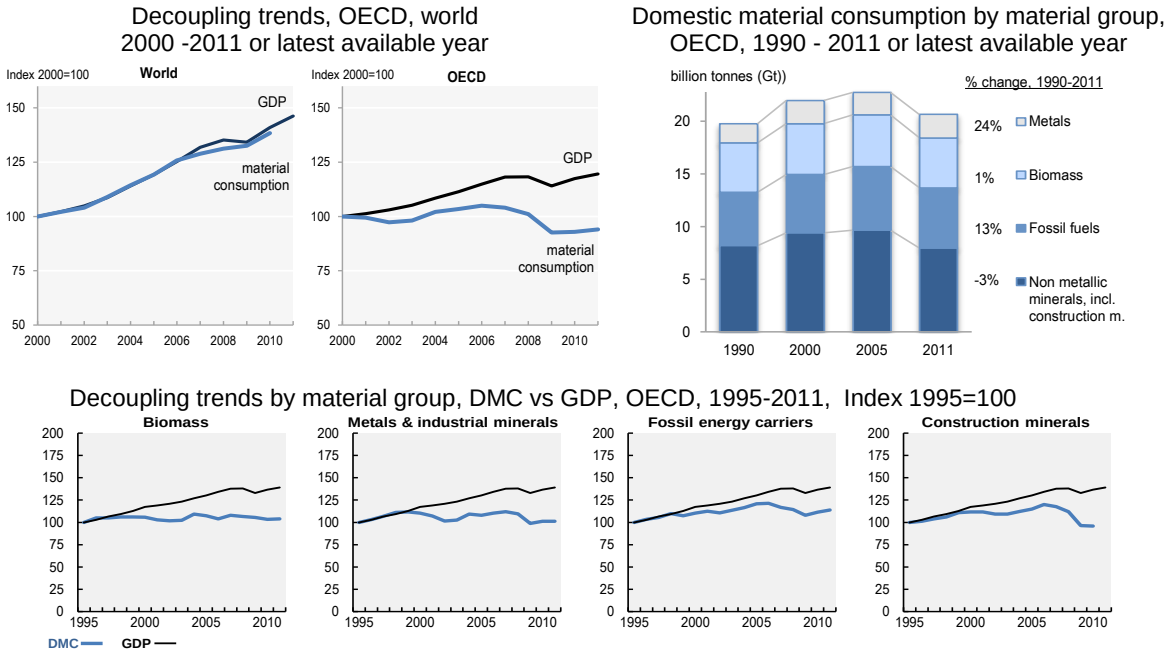
26. Given their weight, construction minerals dominate the material mix (36% of the total) and account for most of the absolute developments in material consumption in OECD countries. An average person living in an OECD country "consumed" about 46 kg of materials per day in 2011, including 17 kg of construction minerals, about 13 kg of fossil energy carriers, and 10 kg of biomass.

27. During the 2000s, material productivity (calculated as the ratio of GDP over domestic material consumption) has been improving in OECD countries; and a decoupling of material consumption from economic growth has occurred overall in the OECD area, across all material groups and all regions. OECD economies today generate 50% more economic value with one tonne of raw materials than they did in 1990 and almost 30% more than in 2000. The domestic material productivity of OECD economies rose from 1400 USD per tonne in 2000 to over 1800 USD per tonne in 2011 (in constant prices and purchasing power parities (PPPs)).

28. Improvements in material productivity can be attributed to policy measures and technological change that led to improved efficiency (see chapter IV), structural changes in the economy, including the rise of the service sector, and the substitution of resource intensive domestic production by imported goods. The economic slowdown due to the 2008 financial and economic crisis plays an important role. The largest gains in material productivity have come in recent years, mainly due to a decline in the demand for construction materials. The consumption of construction materials decreased by 18% between 2007 and 2011; as these materials dominate the materials mix in terms of weight, but contribute comparatively little to GDP, their decrease may lead to an apparent increase in the productivity ratio.

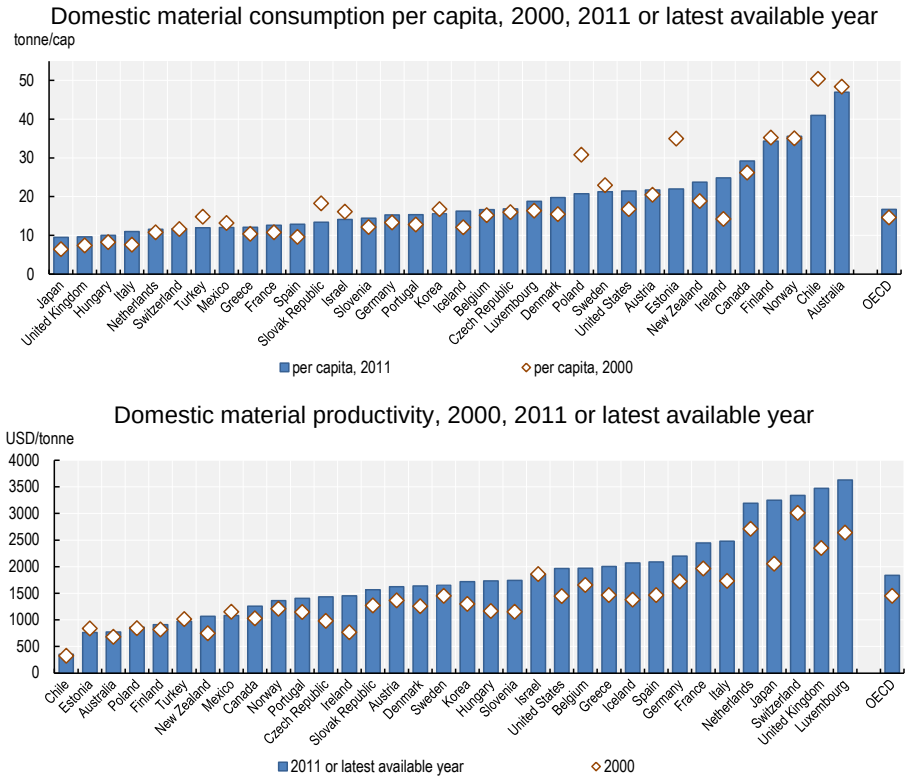
[6] Material consumption here refers to the amounts of primary raw materials extracted from natural resources in the country, plus the amount of materials and other goods imported, minus the amounts of materials and other goods exported. It does not account for the amounts of raw materials that were required upstream to produce imported or exported goods.

Figure 3. Trends in material consumption



Source: SERI and Dittrich, M. (2014). Global Material Flow Database. 2014 Version. OECD (2013). "Material resources", *OECD Environment Statistics* (database).

Figure 4. Domestic material consumption and productivity, OECD countries



Note: *The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.*

Source: OECD (2013). "Material resources", *OECD Environment Statistics* (database).

29. Prior to 2008, there were only a handful of instances of absolute decoupling of material consumption from economic growth, notably in Germany, Japan, and the Netherlands. These countries have high waste recycling and recovery rates, well-functioning waste management and extended producer responsibility schemes, and well-developed resource efficiency strategies. As economic growth resumes, the demand for materials will increase and will exceed pre-crisis levels unless countries strengthen resource productivity policies and measures.

30. As OECD economies become more service-based, their reliance on imports is increasing with resource-intensive production often being displaced to non-OECD economies. Imports make up almost one-third of material inputs in the OECD area, compared to one quarter in 1990. They make up 40% in OECD Europe and in OECD Asia-Pacific; and less than 15% in OECD Americas. If indirect flows of raw materials associated with international trade are taken into account (in addition to the direct flows of traded goods), improvements in resource productivity in countries that are net resource importers are more modest. However, in the absence of reliable estimates for such indirect flows, a detailed OECD-wide analysis of the effects of these flows on resource productivity is not yet possible.

3. Trends in waste generation and management

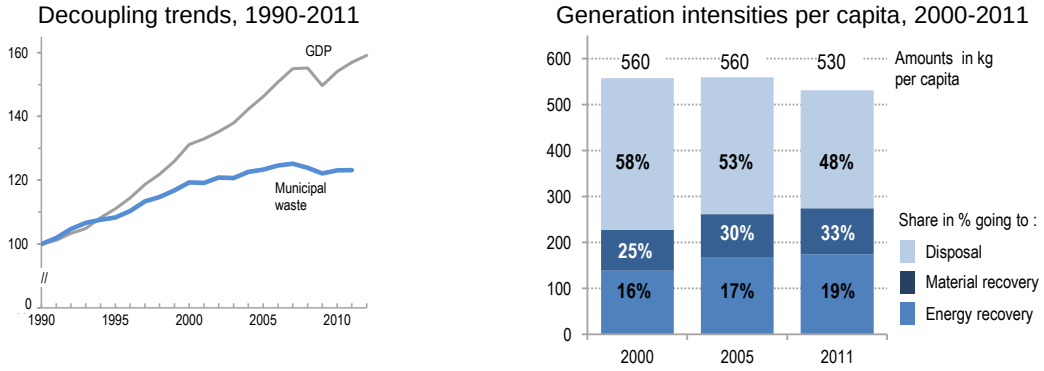
31. The amount of solid waste generated by economic activity is rising in line with growing consumption of material resources. Many valuable materials thus end up as waste and, if not recovered, are lost to the economy. While OECD countries offer a mixed picture on total annual waste generation, with some countries showing a decrease and others an increase, efforts to use waste as a resource start to pay off, and a generally positive trend can be observed in municipal waste.

32. Municipal waste represents roughly 10% of total waste generation in most OECD countries; it includes household and similar waste from households and from some other municipal sources.

- The amount of municipal waste generated per year is around 660 million tonnes; per capita generation has decreased by almost 5% (to 530 kilograms per person compared to 560 in 2000), but remains high compared to other countries in the world, and is still higher than in the early 1990s.
- Municipal solid waste is increasingly being diverted from landfills and kept in the economy through material recovery or recycling.

33. Information on the generation and treatment of industrial and hazardous waste in OECD countries is insufficient to carry out an analysis of trends. However, markets for secondary raw materials are expanding, even if they have to cope with volatile commodity prices. Recycling rates have increased for a large range of important materials, such as glass, steel, aluminium, paper and plastics, reaching levels as high as 80% for some of these materials. There are however many precious or specialty metals that are not recycled or for which recycling rates remain very low.

Figure 5. Trends in municipal waste generation, OECD



Source: OECD (2014). "Municipal waste", *OECD Environment Statistics* (database).

4. Urban mines

34. Raw materials are usually extracted or produced from natural resource stocks. Valuable materials can also be gained from the recovery and recycling of solid waste by diverting materials from the waste stream before final disposal. They can further be extracted from final waste disposal sites such as landfills, where solid waste has accumulated over long periods. Valuable resources are also found in the built environment, and in products and appliances in use. These stocks of materials locked in the economy or future "urban mines" are an important source of minerals and metals for industry, and a potentially important domestic source of raw materials in the future. Waste electric and electronic equipment is of particular interest because it contains many strategic metals, such as gold, palladium and rare earth metals that can be recovered and recycled, as well as not only hazardous substances that require special treatment.

35. The size of the urban mine and its value are not yet well known. But estimates quantifying the amount of raw material locked in the economy indicate that the size of future urban mines could be significant. Anthropogenic stocks of iron for example are estimated between 12 and 18 million tonnes or roughly 15-20% of global iron ore reserves. These stocks could one day be available for reuse or recycling free of technical or economic constraints.

III. PROGRESS WITH REGARD TO THE ANALYSIS OF MATERIAL FLOWS AND THEIR ENVIRONMENTAL IMPACTS

The RP recommendation recommends that Member countries (i) improve the ***scientific knowledge concerning the environmental impacts and costs of resource use***, including from resources that have been imported; (ii) improve the ***data on material flows*** within and among countries and the ***associated environmental impacts***; (iii) implement ***internationally compatible material flow accounts***; and (iv) develop ***indicators*** that assess the efficiency of material resource use, including indicators on the availability, ***quality and deterioration of natural resource stocks***; and indicators on the flows and ***environmental impacts*** of materials.

36. This chapter of the report presents progress made by OECD countries in analysing material flows and their environmental impacts. It builds on information compiled from country contributions to the annual Round Table on Environmental Information held by the WPEI, from replies to the questionnaire on

the implementation of the Recommendation, and from national websites. They update the results of a global survey of material flow activities carried out in 2007[7], and cover all Member countries.

1. Status of implementation in member countries

37. Over the past decade, interest in material flow analysis (MFA) as a tool that provides a more holistic and integrated view of resource and material flows through the economy has been growing. Following pioneering work in the late 1990s and the early 2000s[8,9], important progress has been made in harmonising the ***methodologies*** for MFAcc and indicators. Since 2008, ***practical applications*** of material flow analysis (MFA) and related indicators have progressed stimulated by policy initiatives concerning resource efficiency, green growth and the circular economy.

38. The use of ***material flow accounts*** (MFAcc) has expanded as has the use of material flow ***indicators***, including indicators on resource productivity that parallel those describing labour productivity. Most OECD countries that have developed a national set of environmental or sustainable development indicators include in their set one or several indicators derived from MFA, and almost all OECD countries carry out some activities on resource and material flows and related indicators. Several countries conduct work that helps assessing the ***environmental impacts*** of materials flows. Significant progress is being made in the Europe, where reporting on material flows and on other related flows has become mandatory for all member states of the European Union, as part of a regulation on environmental accounting. This is supplemented by work on natural resource accounts, that generally focus on countries' economically and environmentally most important resources and materials.

39. These developments have been supported by ***international work*** on environmental accounting that led to the adoption at UN level of the System of Environmental-Economic Accounting (SEEA) as an international standard, by statistical and methodological work by Eurostat, and by OECD guidance on environmental indicators, and on the measurement of material flows.

40. However countries are still at a ***variety of stages*** in developing and using MFA and in analyzing the associated environmental impacts. The status of their work, its characteristics and scope, purpose and policy use vary considerably. Some of this diversity is expected, for example in the coverage of resources or materials that reflects the varying economic and environmental importance of a given resource or material flow for different countries. Other differences point to the need for additional convergence and for greater efforts.

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7 OECD (2008c), *Measuring material flows and resource productivity – Inventory of country activities*.

8 Joint research carried out by governmental and non-governmental institutions in Austria, Germany, Japan, the Netherlands and the United States, and collaborative work in Europe carried out by Eurostat on methodologies for economy-wide material flows.

9 WRI (2000), *The weight of nations: Material outflows from industrial economies*, Matthews, Emily, C. Amann, S. Bringezu, M. Fischer-Kowalski, W. Hüttler, R. Kleijn, Y. Moriguchi, C. Ottke, E. Rodenburg, D. Rogich, H. Schandl, H. Schütz, E. van der Voet, H. Weisz , WRI, Washington D.C.

WRI (1997), *Resource Flows: The Material Basis of Industrial Economies ;* Adriaanse, Albert, S. Bringezu, A. Hammond, Y. Moriguchi, E. Rodenburg, D. Rogich, and H. Schuetz,(1997), World Resources Institute, Washington D.C.

Eurostat (2001), Economy-wide material flow accounts and derived indicators – A methodological guide

1.1 Internationally compatible material flow accounts

Economy-wide material flow accounts

41. 27 OECD countries have developed ***economy-wide material flow accounts*** (EW-MFAcc) as a regular activity with annual updates: all EU countries, Japan, Korea and Switzerland. In two countries, work has been carried out on a pilot basis, or as part of ad hoc research work carried out at academic level (United States, Mexico). In Australia, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has done EW-MFA work on domestic and international direct and indirect material flows, even though full material flow analysis at the macro-level is not a national priority.

42. In the European Union, EW-MF work is based on Eurostat guidance, and reporting has become mandatory under an EU Regulation on environmental accounts adopted in 2011. The first data transmission under the regulation took place in Q4 2013 for the base year 2012. The reporting covers 40 to 50 materials and the variables: material extraction, material imports and exports; reporting on material inputs by degree of processing (to distinguish between raw materials, semi-manufactured, and finished products), and reporting on material outputs to the environment (emissions to air and water, outputs from dissipative uses, waste put in landfills) is optional. This development has led to the integration of work on MFAcc in the national systems of official statistics.

Flow accounts for individual materials or natural resources

43. A number of countries have implemented ***physical flow accounts for individual materials or resources*** in areas of particular relevance to the country and its economy (e.g. Australia, Canada, New Zealand, Norway, the United States, and EU countries); these accounts cover natural resources such as water, forests, fish, minerals, energy; or residuals such as air and GHG emissions, and waste. In the EU, the establishment of flow accounts in the field of air and GHG emissions, and soon also energy, is mandatory under the environmental accounting regulation. Waste, water and forest accounts are developed on voluntary basis, often using a ***NAMEA***[10] approach or an ***Input-Output framework***. Such accounts, and in particular their sectoral breakdown are useful complements to EW-MFAcc.

44. The NAMEA approach to material flows is also used in other OECD countries, notably in Japan and Korea. The most developed activities, such as the German Material and Energy Flow Information System (MEFIS), the Australian Stocks and Flows Framework (ASFF), or the Canadian Material and Energy Flow Accounts (MEFA), include physical input-output tables (PIOTs) and use a NAMEA-type breakdown for economic activities in line with the SEEA. In some countries, hybrid flow accounts have been established by linking information from physical flow accounts to economic data from Monetary Input-Output tables.

Material flow cost accounting

45. While in most countries work has concentrated on physical flows of materials, Japan has actively promoted the development of ***material flow cost accounting*** and its use by businesses and other organisations. In 2011, MF cost accounting has been integrated into the family of ISO standards on environmental management (ISO 14051:2011). It establishes an information system, which traces and quantifies material input and output flows and stocks within an organisation, and which can be used to better understand the environmental and financial consequences of material and energy use practices, and to identify opportunities for efficiency improvements.

[10] NAMEA: national accounting matrix including environmental accounts.

Availability and quality of data on material flows

46. To date, time series of ***economy-wide MF data*** are available for major materials and material groups for all OECD member countries. They are available from national accounting activities and from mandatory reporting in Europe, as well as from international work and multi-lateral research projects[11]. The OECD material flow database, set up following the adoption of the 2004 Recommendation by the Council on material flows and resource productivity, extends the data compiled by Eurostat to other OECD countries and the BRIICS[12]. It covers material extraction, imports, and exports (for direct and selected indirect flows) and related indicators for 12 material categories, about 40 materials and the period 1980-2011.

47. Availability and quality are best for data describing direct flows by material category and for ***input and consumption variables*** (material extraction, imports, exports). Output variables such as ***material outflows to the environment*** in the form of emissions or waste, are less well covered. Data needed to populate the output side of material flow accounts are often compiled in different frameworks that do not enable a holistic coverage for the purposes of MF analysis (e.g. waste statistics, emission inventories, PRTRs, other environmental statistics). The use of these data for accounting purposes often requires a restructuring and adaptation to accounting definitions and classifications. The implementation of the SEEA is expected to help advance the measurement agenda in these areas.

48. Gaps also remain as regards data on material flows that do not enter the economy as transactions, but that are relevant from an environmental point of view, including unused materials such as mining overburden, and ***indirect flows of raw materials associated with traded goods.***

49. Data on physical stocks and flows of ***individual material resources*** are available in many OECD countries, but with varying degrees of completeness and coverage. Information on natural resources such as forest, freshwater or energy, is relatively advanced in several OECD countries and compiled in a more or less harmonised framework, the SEEA often serving as a reference (see Annex 1, Table 1). Physical flow information on other material resources or residuals such as non-metallic minerals and selected metals, fish resources, is available in several countries, but appears to be less harmonised across countries. The same applies to information on natural resource stocks and reserves. Reliable data on ***material flows within countries and material use by industry*** remains scarce, despite promising developments in the field of NAMEAs and PIOTs.

1.2 Material flow and resource productivity indicators

50. OECD countries that have developed a national set of environmental, sustainable development or green growth indicators, include in their set one or several indicators derived from natural resource or material flow accounting. These indicators usually describe economy-wide material use and decoupling, as well as related intensity and productivity ratios. They are commonly used to monitor the ***efficiency*** of material resource use and its sustainability at various levels, often with a link to ***waste management*** policies, sometimes with a link to globalisation and trade, and to the security of materials supply.

51. Several OECD countries also use indicators focusing on particular resources, materials, substances, products or industries. Many countries use indicators on waste flows and on their management. Indicators on the availability, quality and deterioration of ***natural resource stocks*** are less developed, as are indicators on the ***environmental impacts*** of material flows.

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11 For example research work on global material extraction (materialflows.net); European research projects (CREEA, DESIRE), and the EU Resource efficiency platform.

12 BRIICS: Brazil, Russia, India, Indonesia, China, South Africa.

52. In a few countries (e.g. the UK), businesses have developed risk indicators that focus on critical material resources and that monitor how different types of resource risks could affect the material supply chain and product portfolio. The risks covered include physical risks (related to resource scarcity), economic risks (related to volatile pricing) and geopolitical risks (related to political barriers).

1.3 Indicators and policy goals

53. In more than half of OECD countries material flow and resource productivity indicators are used to ***monitor progress towards policy goals*** and objectives. These goals and objectives are often embodied in national sustainable development strategies (NSDS), environmental action plans, green growth strategies, national strategies and actions plans on resource efficiency, or waste management plans. They concern the efficient management and sustainable use of natural resources and materials, including for example: decoupling natural resource use from economic growth; supporting eco-efficient measures; improving resource efficiency through the full life-cycle; achieving non-toxic and resource efficient material cycles.

54. In about a quarter of OECD countries, the indicators are associated with ***quantitative objectives (targets)*** on resource productivity or material resource use. In a few countries, the indicators are associated with ***quantitative time-bound targets***.

55. Among the most prominent examples of policy use of MF related information and indicators is that of Japan. In 2003, the Japanese government adopted its Fundamental Plan for Establishing a Sound Material-Cycle Society (SMS). The Plan included a first set of three quantitative time-bound targets to be achieved by the fiscal year 2010 compared to 2000: (i) increase resource productivity (GDP/DMI) by 40%, (ii) increase the cyclical use rate by 40%, and (iii) reduce the amount of waste materials going to final disposal by 50%. The targets build on a cabinet decision, and stakeholders are asked to make efforts to contribute to their achievement. The fundamental Plan and its targets were last revised in 2010. The current targets, to be achieved by the fiscal year 2020 compared to 2010, are:

- resource productivity should reach 460 thousand yens/tonne (compared to 374 thousand yens/tonne in 2010);
- the cyclical use input rate should reach 17% (compared to 15.3% in 2010);
- the final waste disposal amount should be reduced to 17 million tonnes (compared to 19 million tonnes in 2010).

56. Other prominent examples include:

- The German target to improve the productivity of abiotic raw materials by a factor of 2 between 1994 and 2020 (included in the National Strategy for sustainable development and in the 2012 Resource Efficiency Action Plan).
- The Austrian targets to increase resource productivity by at least 50 % between 2008 and 2020, and by a factor 4 to 10 in the long term – i.e. by 2050 – in line with the recommendations of the World Business Council on Sustainable Development (WBCSD). These targets are included in the 2012 Resource Efficiency Action Plan, and follow on earlier targets set in the 2002 Strategy for sustainable development (increasing resource productivity by a factor of 4 in the longer term and decreasing total material throughputs in the short term).

57. In general, and with the exception of waste management indicators in Europe and in Japan, the targets set are not mandatory and rather an expression of desired policy directions. Hence the indicators that monitor progress towards the achievement of these targets are used for communication purposes.

1.4 Knowledge and information concerning the environmental impacts of resource use

58. Work continues to better understand the implications of material resource use and resource productivity for environmental quality, and relate them to well recognised environmental policy concerns. This is most commonly done by conducting scientific research and case studies, by carrying out life-cycle assessments (LCA) of materials or products, and by linking information on material flows to information on pollution or on natural resource stocks.

59. Scientific knowledge about the use of natural resources and materials has ***improved***, among others thanks to joint research work carried out by the International Resource Panel (IRP) steered by UNEP, and to work in countries as described below.

60. There have been a few attempts to weight the various material or substance flows according to their potential environmental impact or toxicity so as to derive a measure of the ***economy-wide impacts*** of the flows. These impact-based weights distinguish between large flows with little impact per unit of flow (inert or bulk materials) and small flows having large impacts per unit of flow (highly toxic or persistent materials). One example is environmentally weighted material consumption (EMC) that combines data from material flow analysis (MFA) and impact coefficients from LCA. EMC has been calculated for a group of European countries and for the Netherlands, but a consensus about the validity of the calculation method was not reached.

61. Since 2008, efforts have rather been focusing on estimating indirect ***demand-based material flows***, i.e. the equivalent raw materials embodied in traded goods. They build on experience in a few pioneering countries such as Germany, Austria, the Czech Republic, and Japan. While not informing about environmental impacts per se, this is seen as one step towards better understanding the environmental consequences of material resource use and where they take place. It also helps to identify the raw material requirements of an economy and to what extent improvements in resource productivity are the result of domestic policies. An international consensus on measurement methods does however not yet exist; it could benefit from further exchange of experience among countries and institutions active in this area of work.

62. Some countries study ***flows of specific substances or groups of substances*** (e.g. heavy metals and other substances with potential negative impacts on the environment and human health). Examples include work carried out by the Norwegian Pollution Control Authority and the Swedish Chemicals Inspectorate. Many countries use their Toxic release inventories (TRI) and Pollutant Release and Transfer Registers (PRTR) to monitor releases of particular substances and materials, but their work does not consider the full life-cycle of these substances.

63. Other studies dwell upon ***priority resources, products or materials*** with the aim to make specific supply chains more sustainable and to inform consumers about the environmental impacts of products. Examples include:

- Research carried out in the Netherlands to identify the resources and materials used in the Dutch economy that have the highest environmental impacts.
- Systems analysis carried out in France to (i) optimise the use of secondary raw materials in construction and public works at territorial level, and (ii) monitor flows of primary and secondary rare earth materials (study involving the business sector).
- Demonstration projects conducted by the United States as part of "Sustainable materials management: the road ahead", to show the value of life cycle materials management and gain greater insight on integrating policies and programs around materials management. To identify the materials to be covered in these projects, a relative ranking of materials, products, and

services using selected environmental criteria was done. The ranking used a ***multi-factor analytical approach***, based on LCA concepts; it ranked 480 materials, products, and services consumed in the United States economy considering five environmental aspects: environmental impact (13 different measures); energy use; material use; material waste; water use.

- Life-cycle assessments of the environmental impacts of products carried out in several OECD countries, and information of consumers through appropriate labelling of products.

64. Overall, systematic analysis of particular materials or substances is however ***not yet well developed***; information on the environmental impacts of resource use remains scattered, and only a few studies provide a holistic integrated view of the material or substance flows assessed.

1.5 Institutional arrangements and partnerships

65. Work on the measurement and analysis of material flows and resource productivity is often carried out by academics or by national statistical offices, and in a few cases environment ministries and agencies, sometimes in cooperation with ministries of industry or trade.

- The production of MF accounts and data is generally in the hands of ***national statistical offices*** (NSOs) as part of their environmental accounting activities or of research institutes. In a few countries, ***academics*** (research institutes, universities) have the lead in conducting MF research on behalf of their government sometimes with government funding and/or in co-operation with government agencies.
- The development and publication of material flow and resource productivity indicators, and their use in environmental reporting is often shared among ***NSOs and environment agencies and ministries***, and sometimes ***research institutes***. The practical arrangements depend on the stage of development and the status of the indicators work, and on already existing arrangements in the field of environmental indicators and reporting.
- Studies on the environmental impacts of material flows are often carried out by research institutes and commissioned by ***environment agencies, ministries or inspectorates***.
- Studies on raw materials and supply security are often conducted by or in cooperation with ministries and agencies in charge of ***industrial policies and entrepreneurship***.
- In countries where MF work is well advanced, ***partnerships*** are commonly established among various partners within the country as well as with international networks and with partners in other countries.
- Some countries exchange information with and provide ***assistance to non OECD countries*** via their research activities or development cooperation projects. Examples are bilateral partnerships established between Japan and the People's Republic of China (hereafter 'China'), and between Switzerland and Colombia, and academic partnerships established by research institutes to promote the application of MFA in developing countries.
- The EU has several international partnerships of relevance to resource productivity, including dialogues on raw materials (EU-Latin America dialogue on raw materials, EU-United States dialogue).

2. Remaining gaps and areas for further progress

66. Many of the positive developments described above relate to macro-level accounts and overview indicators whose development started in the early 2000s. Specific progress made in implementing the provisions of the RP Recommendation is insufficient. Missing information and inconsistencies still limit

the tracking of progress with resource productivity in many countries and hence at international level. Scientific knowledge of the ***environmental impacts*** of material flows has progressed, but remains incomplete; little progress has been made in analysing the ***environmental costs*** of material resource use. Data on physical stocks and flows of ***individual material resources*** is of varying quality. Reliable data on ***material use by industry*** and on the availability, quality and deterioration of ***natural resource stocks*** is scarce and often not comparable, and little information is available on the ***environmental and economic costs***[13] of resource use.

67. The most important gaps with respect to the provisions of the RP Recommendation relate to:

- Methods for assessing the ***environmental impacts*** of resource use throughout the entire life cycle of materials and the products that embody them, including impacts from resources that have been traded.
- International flows of materials, and in particular ***flows of raw materials embodied in traded goods***. The main challenges in estimating such indirect demand-based materials flows are: gaps in reliable ***physical data on international trade***; lack of an international consensus about the calculation methods and conversion factors to be used; lack of an agreement to use a ***common international database*** (input-output) on which to base demand-based measures of environmental services. Distinguishing between the materials and products directly used in an economy and the raw materials that are required upstream to produce these products is important to understand the full raw material requirements of an economy, to detect the effects of domestic policies on resource productivity, and to become aware of the environmental consequences that may occur abroad.
- Flows of materials that are important to a circular economy and the 3Rs, including flows of ***secondary raw materials*** (recycled materials) and of waste. The main challenges are: conceptual and methodological differences between material flow accounts and waste statistics; gaps in physical and monetary data on international trade in secondary raw materials. Distinguishing between primary and secondary raw materials is crucial for assessing resource productivity and decoupling trends, and for understanding the economic benefits of a circular economy.
- Material resource use and productivity disaggregated ***by industry*** and by type of material, and information on the ***processing levels*** of the materials (raw materials, semi-finished products, finished products). Such information is indispensable to identify opportunities for improved performance and efficiency gains in production and consumption processes and along the supply chain.
- Compatible international data for ***key materials and substances***, including critical raw materials, environmentally harmful substances and substances that play a role in global biogeochemical cycles or raise global concerns.

68. Gaps also remain as regards the size and value of ***future urban mines***, i.e. the material stocks locked in the economy. With the exception of the some of the most common industrial metals, there are insufficient estimates of the size of urban mines to form a reliable picture of their potential to contribute to future supply, and how they relate to virgin stocks. Other important gaps include information on economic and fiscal instruments in use, including ***subsidies*** for resource extraction and use, beyond those for fossil fuels, and other market-based instruments. Also, links between trends in material flows and trends in ***market prices*** for these materials, or trends in related ***resource rents*** remain largely unexplored.

[13] For example, costs associated with the loss of productivity due to inefficient use of material resources, negative effects of materials and product use on human health, labour productivity, and ecosystem services, etc.

3. The way forward

69. OECD Members will need to make additional efforts to monitor progress with resource productivity. Improvements are needed in particular as regards knowledge and information on the ***environmental impacts and costs*** of material resource use throughout the life-cycle of materials, including impacts from resources that have been traded. Work carried out so far to establish compatible material flow accounts and international databases needs to be consolidated and the quality of data on material flows and resource productivity needs to be improved. This requires, among others, more work on definitions, methodologies and conversion factors, an international consensus about the validity of the methods applied, and major efforts to harmonise the way in which material and waste flows are monitored and accounted for.

70. There is also considerable scope for ***deeper analysis*** of particular resources and materials, and the interactions between these resources. Examples include ***trade*** related resource flows and flows of ***secondary raw*** materials, the way they interact with ***commodity prices and recycling markets***, and how they relate to natural ***resource stocks*** and supply security, and to innovation. Further progress in delivering ***industry-level*** and ***material-specific*** information to support sustainable materials management and indicate opportunities for improved performance and efficiency gains along the supply chains would also be welcome. Future work will also need to explore in greater detail the ***economic and environmental opportunities*** provided by improved resource productivity and sustainable materials management.

71. Continued efforts are being ***undertaken by the OECD*** to assist in the development and use of MF and RP data and indicators, both in OECD work and in OECD member countries, to promote the exchange of related experience with non OECD economies, and to monitor and report on the state of resources and resource productivity in OECD countries and beyond.

- The OECD will continue to further develop internationally harmonised material flow and resource productivity data and indicators (both at macro level and for selected materials such as critical raw materials and materials raising particular environmental concerns). This is done in collaboration with UNEP and its International Resource Panel, Eurostat and several research institutes. . International cooperation has also been established to advance the measurement and knowledge of green growth (GGKP, OECD, WB, UNEP).
- Efforts are underway in the Environment Policy Committee and the Committee on Statistics and Statistical Policy to support the implementation at international level of the System of environmental economic accounting (SEEA); this is done in cooperation with UNSD and the World Bank. A specially dedicated OECD Task Force has been established to this end.
- Further analysis of material flows, raw material requirements and their economic, trade and environmental implications will be carried out as part of the organisation's work on green growth.
- Analysis of resource scarcity with a focus on non-renewable resources will be carried out as part of the EPOC project on "Costs of Inaction and Resource scarcity: Consequences for Long-term Economic growth" (CIRCLE), which aims to assess the feedbacks from environmental and resource challenges on economic growth, and the benefits (and trade-offs) of policy action.

IV. PROGRESS WITH REGARD TO THE DEVELOPMENT OF RESOURCE PRODUCTIVITY POLICIES

72. The RP recommendation recommends that Member countries take appropriate actions that (i) promote ***integrated life-cycle-oriented approaches***, such as 3R policies (Reduce, Reuse, and Recycle), sustainable materials management and sustainable manufacturing; (ii) promote the use of ***new technologies and innovations***; (iii) encourage co-operation and ***sharing of best practices among enterprises***; (iv) establish framework conditions that improve resource productivity through ***economic instruments***; and (v) ensure that the policy measures taken are efficient in economic terms, effective in environmental terms and equitable in social terms.

73. This chapter of the report presents the progress made by OECD countries in developing and implementing resource productivity policies. The focus is on sustainable materials management (SMM), as an important approach to increase resource productivity in line with the Recommendation. This approach has been developed and promoted by the OECD since 2004. The chapter builds on information compiled from the regular round tables held by the WPRPW; on a survey on SMM policies that was conducted among Member countries in March 2011[14] and that updated an earlier survey in 2007; on a survey on global use of extended producer productivity schemes carried out in 2013, and on replies to the questionnaire on the implementation of the Recommendation. The chapter also draws upon information provided by countries to update the "OECD database on instruments used for environmental policy and natural resources management".

74. Aspects related to new technologies, innovation and sustainable manufacturing, while integrated in the SMM concept, are not assessed in detail in this report.

1. Improving resource productivity through Sustainable Materials Management – OECD policy principles and guidance

75. Governments have long focused on managing waste as a means of managing the negative impacts of materials use on the environment. While much has been achieved with waste management policies, research has shown that waste management alone is not the most effective process for improving resource productivity, controlling material flows in the economy and limiting their environmental impacts.

76. Economic theory suggests that market failures such as environmental externalities, i.e. environmental costs that are not transmitted through market prices, are often best addressed through economic instruments such as taxes and charges. This approach achieves an efficient use of environmental resources by all economic actors at the lowest possible cost to the economy. However, economic instruments can be challenging to implement due to political and social resistance to their introduction and the difficulty to determine the exact cost of the externality.

77. As a result, policy makers have often created policies that address specific materials, products, natural resources or life-cycle stages. This leads to a highly fragmented policy landscape where a range of policy instruments are used in addition to market-based instruments. For instance, despite the introduction of the EU's Carbon Emissions Trading Scheme (ETS), climate change policy in EU Member States is

[14] In 2011, 16 countries participated in the survey, including the two additional new members: Chile and Slovenia, plus the EC. Among the responding countries, seven belong to the G8 (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States). The questionnaire was also sent later to the Russian Federation for information. In summary, the outcome of the survey is based on responses from 7 countries of the G8 (i.e. G8 less Russia), 9 other OECD countries and the EC.

supported by a broad range of other, additional policy instruments, such as feed-in tariffs for renewable energy, subsidies for better insulation of buildings and CO_2 emission standards for vehicles. While addressing complex environmental issues usually requires the use of a ***mix of different policy instruments***, there is an inherent risk that it lacks integration and coordination. This may in turn lead to economic distortions and to shifts in the environmental burden from one environmental medium to the other or from one phase of the material life-cycle to the next, thus undermining efforts to achieve an economy-wide reduction of environmental impacts and an increase in resource productivity.

78. This is why the OECD has been working with its Members to explore new, more integrated approaches to materials management. The work started in 2004. It has focused on identifying the policies and instruments that help to achieve a **sustainable materials management (SMM),** and as of 2008 to implement the OECD Council Recommendation on Resource Productivity. The work encompasses policy studies on target setting, policy principles and policy instruments for SMM, as well as case studies for selected materials: aluminium, critical metals for mobile phones (antimony, beryllium, palladium and platinum), wood fibres, plastics (non-packaging). It is sought to provide practical guidance for policy makers who wish to improve the resource productivity of their economies and put in place sustainable materials management policies. The work built on countries' experiences, and was supported with a Global Forum on Sustainable Materials Management (October 2010, Mechelen, Belgium).[15]

79. The main results of this work, starting with policy principles and policy frameworks, as well as a discussion of the benefits of SMM, are presented below. Countries experiences with policy instruments and target setting are described in section IV.2.

Box 2. OECD working definition for Sustainable Materials Management

Sustainable materials management (SMM) is defined as

"*…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.*".

Explanatory notes:

- *"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."*

Source: OECD (2012b), *Sustainable Materials Management: Making Better Use of Resources.*

1.1 Policy principles

80. Evidence from experience in OECD countries suggests that, to be successful, the development of SMM policies should follow four broad principles (OECD, 2011c).

15 See www.oecd.org/environment/gfenv

Principle 1 – Preserve natural capital

81. 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 modelling 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.

82. Strategies for SMM Policy principle 1 include:

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

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

83. 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 to 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 and supply chain, or from one geographical region, to another. Economic and social outcomes are optimised while natural capital is preserved and materials are sustainably managed.

84. SMM policy principle 2 also calls for increased co-operation 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** means reduction of the toxic characteristics of materials used in products and processes. This can be accomplished by reducing the volume of toxic materials used in a process or production, by substituting more benign substances for toxic materials, or by changing the toxicity of materials through chemical changes that reduce or eliminate their toxic properties. (Source: Geiser, K. 2001)

  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** means an absolute or relative reduction in the use of material and energy per unit of value added or output (Source: Eurostat, 2001). It covers many aspects of materials-related policies such as material efficiency in the supply chain, energy efficiency, eco-design of products, transport in the supply chain, material reuse, waste recovery and recycling, closing material cycles, substitution of services for products.

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 without decreasing the quality of the service they provide. 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 "cradle-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.

85. 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.

86. 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.

87. 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 across the life-cycle of materials use 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:

- Multilateral stakeholder engagement, responsibility and collaboration;
- Open information flows;
- An ethical perspective.

1.2 Policy frameworks

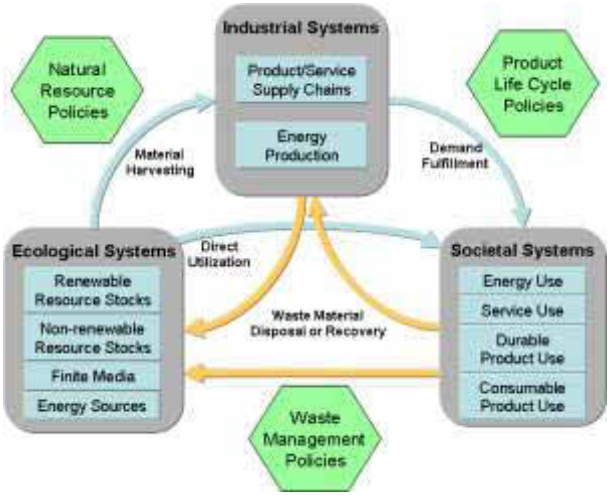
88. Due to the broad scope of SMM, it is helpful to adopt a conceptual framework that provides a systems perspective of material resources and their management, and that represents the sources of materials, their pathways through the environment, and their eventual sinks. Policy frameworks can then be classified in terms of their **scope of application** with regard to material flow cycles (Figure 6):

- **Natural resource policies** (e.g. the 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. the EU Integrated Product Policy) address material flow cycles that link industrial and societal systems, including product development, transportation, energy production, supply chain operations, and waste recovery.
- **Waste management policies** (e.g. the Japanese Fundamental Law for Establishing a Sound Material-Cycle Society or the German law on the circular economy) address the flows of waste materials in industrial systems and into natural systems, including disposition or recycling of industrial and municipal wastes, and non-point source pollution control.

89. The most effective policies take a whole of life-cycle perspective and address each of these policy domains.

Figure 6 Systems view of material flow cycles and policy frameworks



Source: OECD (2012b), *Sustainable Materials Management: Making Better Use of Resources.*

90. Some of the key aspects to be considered when establishing and implementing SMM and Resource Productivity policy frameworks include:

- The need for a variety of aligned programmes, policies, and initiatives that take into account both a comprehensive SMM/RP policy as well as objectives of specific elements within that. Given the scope of SMM, it will affect numerous ministries (e.g., environment, economy, finance, labour), industries, and environmental media (e.g., air, water, land). This will likely require new partnerships and communication channels between previously independent groups.
- The need to well understand the system in question before defining policies, selecting instruments or setting targets. This includes factors such as: the time dimension (e.g., differences in product design cycles); the inter-relationship and opportunities between SMM targets and other activities and objectives (e.g., job creation linked to recycling infrastructure); as well as the aspects (e.g., design, waste, recycling) or impacts that should be addressed by the policy.
- The potential for inducing systemic change, or in other words the capacity of SMM policy makers to "change the rules" through new policy. This is determined by policy makers' authority, both in terms of jurisdictional control over policy implementation as well as their ability to monitor and enforce the policy. This is frequently complicated by market influence and material flows which often cross national borders. It is also important to understand who controls the strategic levers required (e.g., the availability of technological solutions) to affect the change desired.

1.3 Benefits of SMM

91. Implementing SMM in accordance with OECD guidance (the four principles described above), helps to increase resource productivity and generates a number of benefits (Box 3).

Box 3. Benefits of sustainable materials management (SMM)

Reduce life-cycle environmental impacts

By reducing the release of GHG and of toxic substances to the environment, limiting human exposure and diminishing the quantities of raw materials that need to be extracted, SMM helps to minimise environmental impacts and to reduce pressures on natural resources.

Improve policy coherence

By balancing the social, environmental, and economic considerations throughout the life cycle of a product or material, and by ensuring that negative impacts are not shifted from one phase in commercial cycle to the other (e.g. from production to consumption), SMM helps to identify and overcome possible policy incoherences.

For example, a range of waste policies are supporting waste minimisation, such as encouraging consumers to buy food and other products in larger containers that minimise the amount of packaging waste per unit of food. While this is a useful approach, the parallel issue of minimizing food waste also needs to be taken into account. Some life-cycle studies suggest that food can have a significantly larger environmental footprint than the packaging that is wrapped around it. In a one litre milk container, for instance, the milk can generate about five times as much CO_2 as the packaging material that contains it. Hence, when consumers buy large containers and end-up throwing away perished food products, the environmental impact may in many cases be worse than if they had bought smaller packages leading to less food waste, but slightly more packaging waste (Foster C. et al., 2006).

Another example of a policy coherence issue relates to Green Procurement and the potential double counting of externalities. When introducing green procurement, explicit attention needs to be given to the extent of internalisation of environmental costs to avoid that green procurement criteria are used to address environmental impacts that have already been internalised through other policies, such as a tax or an emission standard.

Reduce dependency on primary raw materials

By improving resource productivity and increasing the amount of production that can be achieved with every unit of material and by returning material that has reached the end of its useful life to the economy through **reuse or recycling,** SMM helps to reduce dependency on primary raw materials and improve supply security. In Japan for example, the implementation of policies in line with the 3Rs (Reduce, Reuse, Recycle) in the framework of the "Fundamental Law for Establishment of a Sound Material Cycle Society", have helped to increase the cyclical use rate of materials. This rate relates recovered material resources to total material input in Japan's economy and has improved by 41% since 2000, reaching 14.1% in 2008, and 15.5% in 2010. As a result of this and other efforts, Japan's material productivity was more than 70% higher than the OECD average in 2011 (OECD, 2014).

Improve competitiveness at no or low cost

By reducing input costs, SMM helps to improve competitiveness . A German study showed that companies can reduce their material costs by up to 20% by exploiting their efficiency potential (Kristof 2010). In the United Kingdom, potential input savings to firms from unexploited resource efficiency savings with a pay-back period of less than one year were estimated at GBP 23 billion in 2009, with about GBP 18 billion of waste reduction and better materials management. Further savings of about GBP 33 billion with a payback of more than a year would be available, again with the lion's share (GBP 22 billion) in waste reduction and material management (DEFRA, 2011). One global clothing firm identified that managing waste in its shoe manufacturing process cost it EUR 550 million per year. As part of a long-term programme of resource efficiency, streamlining of production and improved design of shoes reduced waste by up to 67%, energy use by 37% and solvent use by 80% along its supply chain.

Contribute to growth and jobs

By stimulating innovation and generating additional economic activity in areas such as waste collection and treatment or recycling, SMM has the potential to create growth and jobs. In the European Union, the output of firms that generate environmental goods and services has doubled between 2000 and 2011, reaching EUR 600 billion; their contribution to GDP, in terms of gross value added, has grown from 1.6% to about 2.0%; and they provide more than 4 million jobs (in full time equivalents), an increase of about 44% since 2000. The implementation of a comprehensive resource efficiency and waste policy, associated with revised legally binding waste management targets, is estimated to lead to the creation of more than 180 thousand direct jobs, most of them impossible to delocalise outside the EU.

As part of its Resource Efficiency Programme (ProgRess), the German Federal Government (2012) evaluated the market potential of the circular economy. The results show that the annual growth rates of waste and recycling treatment installations are around 3%. For high-tech recycling procedures, such as rapid sorting technologies for different types of plastics, growth rates of up to 15% per year until 2020 are projected.

Source: Based on OECD (2012b), *Sustainable Materials Management: Making Better Use of Resources, and on national sources.*

2. Status of implementation in Member countries

2.1 Policy frameworks used in countries to address resource productivity and materials management issues

92. A review of policies contributing to RP and SMM objectives in OECD countries identified a broad range of policies and policy targets that are currently in use and that address different stages of the material life-cycle. These range from policies focusing on a single life-cycle stage (such as pay-as-you-throw systems to promote more waste separation at the level of consumers) to policies that cut across different stages of the life cycle (such as zero waste or detoxification policies).

The concept of SMM is increasingly reflected in environmental policies of OECD countries

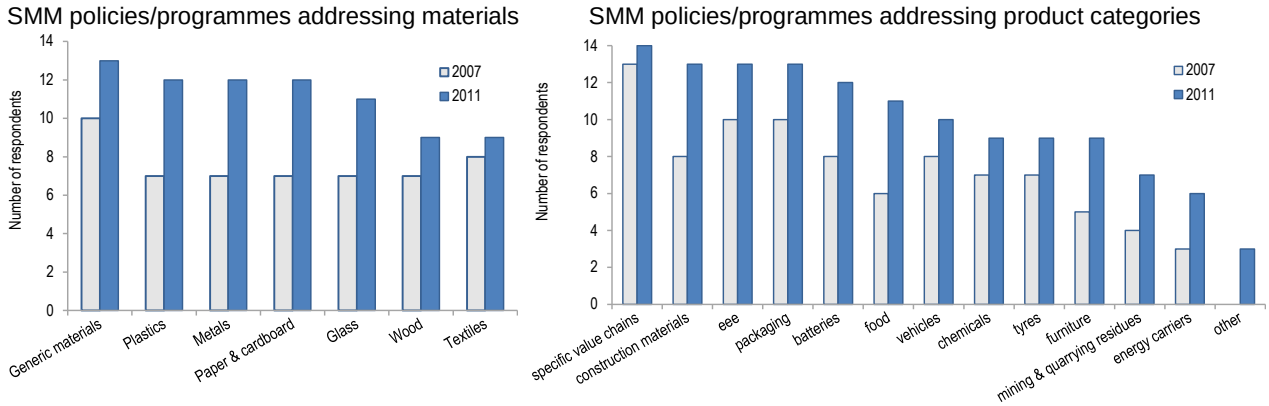
93. The concept of sustainable materials management is increasingly seen by countries as a driving mechanism for improving resource productivity; and its translation into policies and programmes has expanded since 2008. The number of OECD countries that report that they have a national SMM definition in place has doubled to 50% since the first survey in 2007. Also, 50% of OECD countries now have policies that specifically address SMM. Most of these policies are environmental policies.

SMM policies are multifaceted

94. In most countries, SMM policies address materials as well as specific product categories, and the scope of these policies has expanded significantly in recent years, i.e. a greater number of countries are covering a larger number of materials and product categories. The most frequently covered materials are plastics, metals and paper & cardboard, while wood and textiles are covered to a lesser extent. Concerning specific product categories, 75% of countries that responded to the survey report that they have policies in place which address construction materials, electrical and electronic equipment (EEE) and packaging. At the low end, only 20% and 25% report that they respectively address energy carriers and mining and quarrying residues. Construction materials have seen the greatest increase since 2007, and as a result have surpassed EEE and packaging. (Figure 7).

95. Responses demonstrate that both types of approaches whether they target materials or product categories co-exist and complement each other; only one approach would not be sufficient to achieve full SMM.

Figure 7 Characteristics of SMM policies and programmes



Source: OECD, WPRPW, Sustainable materials management survey 2011, unpublished.

96. In addition, the increase in SMM policies targeted at product categories shows that countries are improving their ability to address more complex issues, beyond the end-of-life management of specific materials. Countries tend to control the stages of the life-cycle that take place on their territories (such as manufacturing and disposal), which is easier to do, rather than those life-cycle stages that take place abroad.

97. Only a few countries indicated that they have SMM policies targeting specific stages of the life-cycle of materials. It is possible that most countries have turned their attention to products instead of focusing on the up-stream activities of material production such as resource extraction. Most countries are focusing efforts on the manufacturing and provision of services stages of the materials life-cycle. A minority of respondents (Austria, Canada, the United States and the EC) have developed policies that seek to address several/all stages of the materials life-cycle (Box 4).

Box 4 An initiative addressing the material extraction phase in Canada

Green mining is about finding innovative ways to minimise the waste produced by mining, transform it into environmentally acceptable resources for other uses, and minimise impacts on water, landscapes and ecosystems. The C$8M Canadian Green Mining Initiative (GMI) offers a holistic approach that addresses all steps of the mining process. The initiative is based on four broad research and innovation pillars: 1) footprint reduction; 2) innovation in waste management; 3) mine closure and rehabilitation; and 4) ecosystem risk management. The GMI is led by Natural Resources Canada in partnership with a variety of stakeholders, including federal, provincial and territorial ministries as well as key players from industry, universities, non-profit organisations, and others.

Source: OECD (2012b), Sustainable Materials Management: Making Better Use of Resources.

2.2 Policy instruments used in countries to address resource productivity and materials management issues

98. OECD countries are increasingly focusing their policies across the life-cycle, with a progressive shift away from an end-of-life focus. Similarly, policy instruments are increasingly used within broader packages and programmes so as to address material use across the whole life-cycle. A classification of policy instruments on this basis is difficult, however, because of the breadth of policies which can fall under the SMM definition.

A broad range of policy instruments

99. Countries use a broad variety of ***policy instruments*** to implement SMM depending on the policy approach taken. Dematerialisation and detoxification are the most commonly used approaches in achieving progress toward SMM: 94% and 82% of respondents[16], respectively, use such policies. Policies that seek to internalise externalities are being used less frequently as only 65% of respondents indicate that they use them, but an additional 25% indicate that they plan to use such policies in the future.

- ***Dematerialisation*** has a very broad scope and covers virtually every stage in the life-cycle of products and materials. Dematerialisation policies therefore require the use of a ***mix of different policy instruments***. The use of regulatory instruments combined with economic instruments, which is typical in waste management policies, has proven to be efficient in reducing the generation of waste and improving recycling rates. In this regard the application of the Extended Producer Responsibility (EPR) system associated with taxes and deposit-refund systems is often cited as being efficient for managing material flows such as electric and electronic equipment

16 Respondents to the 2011 SMM survey, with a total of 17 respondents.

(EEE), vehicles, batteries tyres, packaging, as it positively influences the behaviour of producers beyond the end-of-life phase of the life-cycle.

- ***Detoxification*** policies more systematically use ***regulatory instruments*** both at national/regional and international levels (such as in the European Union's REACH regulation for chemicals[17] or the Stockholm Convention for Persistent Organic Pollutants). In many cases, regulations are complemented by ***information-based instruments*** (especially destined for SMEs), and partnership programmes.

100. A majority of countries (mainly European countries and Japan) seem to favour ***legally binding instruments*** (such as regulatory and economic instruments) to implement SMM policies, whereas a few countries such as the United States, the United Kingdom and Canada, favour a mix of regulatory and voluntary approaches to implement SMM policies. Some voluntary, market-based initiatives related to products that involve industry and other stakeholders have also been reported as successful. Examples include the Electronic Products Environmental Assessment Tool (EPEAT) in the United States and the Chemical Leasing in Austria (Box 5).

Box 5 A Voluntary Initiative of the Chemicals Industry addressing business model in Austria

"Chemical Leasing" is an innovative approach favouring the provision of service/know-how instead of the quantity of chemicals sold and used. The producer sells the functions performed by the chemicals which are the main basis for payment. In this system, the responsibility of the producer and service provider covers the management of the whole life-cycle of the product.

Source: OECD (2012b), Sustainable Materials Management: Making Better Use of Resources.

Internalisation of externalities

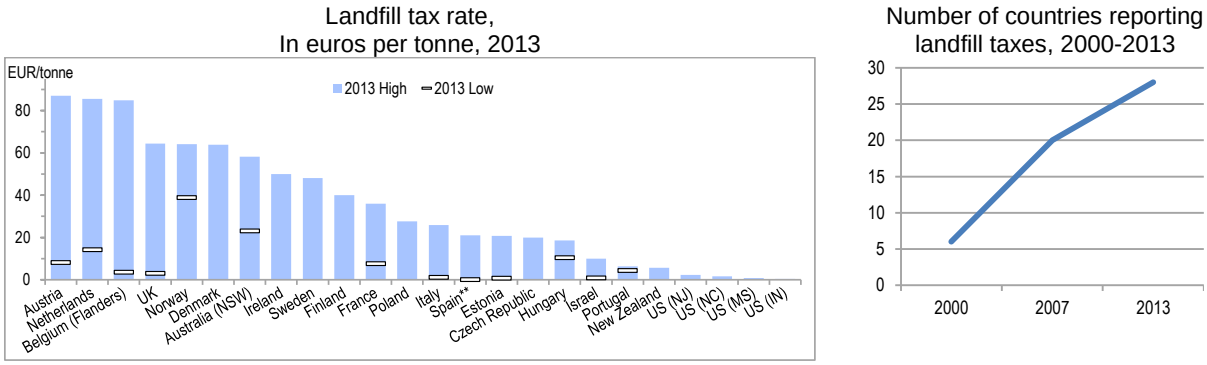
101. The ***internalisation of environmental externalities*** arising from materials management (i.e. extraction, use (such as pollution) and disposal or recovery) is achieved mainly through ***economic/market instruments***. The most frequently used are taxes (in application of the PPP) on wastes, certain waste management practices (landfilling and incineration), construction materials, and fossil fuels. Voluntary programmes on unit-based pricing for municipal waste are also used (e.g. in the US).

102. The trends indicate an increased use of economic instruments in SMM policies. This is confirmed by data from the "OECD database on instruments for environmental policy and natural resources". This database contains information about the policy instruments that OECD Member countries use to address a broad range of environmental issues, including waste management. The data show that the use of economic instruments in waste management policies has been growing steadily since the first datasets were collected in 2000.[18] For instance, the number of countries reporting the use of landfill taxes increased almost five-fold between 2000 and the latest update of the database in 2013. Similarly, the level of landfill tax rates has been increasing significantly in many countries over that same period. The landfill tax rate for some municipal solid wastes is now equal or above 40 EUR/ton in 11 countries, while this was the case in only 5 countries in 2007 and only in one in 2000. Similar trends can be observed for the use of incineration taxes, even if such taxes are a more recent phenomenon and far fewer countries apply them, yet.

17 REACH is the EU policy for the Registration, Evaluation, Authorisation and registration of Chemicals.

18 Note that the some share of the increase in the number of economic instruments may be due to an increase in member-country reporting rather than an actual increase of the use of such instruments. The author of this report, however, believes that a significant share of the increase is attributable to an actual increase in the use of economic instruments.

Figure 8 Landfill taxes for municipal solid waste



Note: *The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.*
Source: OECD database on instruments for environmental policy and natural resources. http://www2.oecd.org/ecoinst/queries/Default.aspx

Extended producer responsibility

103. A similar trend can also be observed for the use of ***extended producer responsibility*** (EPR). EPR is a broad collection of environmental policies encouraging or requiring manufacturers to accept financial and/or physical responsibility for their products after the point of sale. Rather than a specific policy, EPR is better described as a set of policies that policymakers can select from, which can easily adapt to local values, legislative climates, economic contexts, or legal constraints. EPRs can be implemented by using one of three basic categories of instruments:

- take-back requirements (recycling targets and producer take-back mandated by governments);
- economic instruments;
- performance standards.

This includes incentive-based instruments such as deposit/refund (where a deposit is charged at the point of sale and then redeemed when the product is brought back to a collection point), advance disposal fees (where a fee is charged at the point of sale or directly from the producer or importer), material taxes and the upstream combined tax/subsidies (which works like a deposit/refund system, but the charge is levied upstream at the level of the producer and a subsidy is paid to collectors and recyclers). EPRs also can be voluntary, industry lead initiatives or mandated by governments.

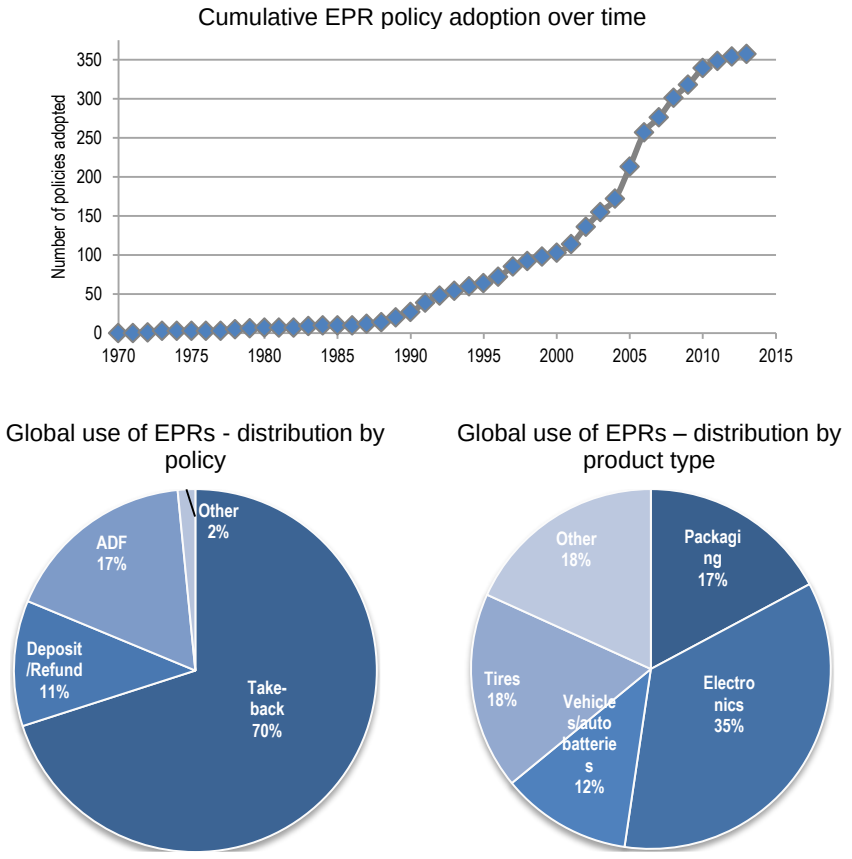
104. A 2013 OECD survey of global use of extended producer responsibility shows that there are now nearly 400 such schemes in operation, of which a majority take the form of take-back requirements (70% globally). Advance disposal fees (17%) and deposit/refund schemes (11%) are the next most frequently used type of EPR scheme. The other EPR policy instruments (upstream combined tax/subsidy, recycling content standards, and virgin material taxes) are sparsely used, if at all (OECD 2014a).

105. The largest number of EPR schemes cover small consumer electronics. Including mobile phones, renewable batteries, thermostats and auto switches, this accounts for 35% of all EPR policies globally (Figure 9). Packaging (including beverage containers) (17%), tires (18%) and vehicles/lead-acid batteries

(7%/5%) are the next largest groups of products covered.[19] The remaining 18% of polices cover less common products including used oil, paint, chemicals, large appliances, and florescent light bulbs.

106. Finally, similar to landfill taxes, the use of EPRs has seen a marked increase over the last decade (Figure 9). Of the 384 EPR policies covered in the OECD survey, over 70% have been implemented since 2001. Breaking it down by decade, 6% of policies were implemented prior to 1990, 22% between 1990 and 1999, 62% between 2000 and 2009, and 11% were implemented from 2010 to the present. Of the types of policies adopted within the last decade, take-back policies appear the most popular, while many of the deposit/refund and ADF policies were implemented in past decades.[20]

Figure 9 Global use of extended producer responsibility (EPR)



Note: Other includes upstream combination tax/subsidy (UCTS) and recycling content standards.

Note: Other includes used oil, paint, pesticides and chemicals, appliances and other less common products.

Source: OECD (2014a), *What have we learned about extended producer responsibility in the last decade – A survey of the recent EPR economic literature*, forthcoming

19 Vehicles and auto batteries are included together due to the fact that End-of-Life Vehicle recovery in the EU includes auto batteries.

20 This is of course not universally true, as there are a few cases of take-back policies implemented in the late 80's and early 90's, and a several cases of deposit/refund or ADF implemented recently.

107. Comparing internationally, the United States appears slightly more inclined to adopt market-based policies such as deposit/refund and ADF (50/50 split between take-back and market-based policies) relative to the rest of the world (80% take-back, 20% market based-policies), though there are many examples of take-back schemes within the United States and deposit/refund and ADF policies outside the US (OECD 2014a).

108. Overall, these policy developments are strengthening the implementation of the polluter pays principle and reinforcing incentives for waste prevention and recycling in the countries that apply them. These policies have played a significant role in diverting waste from landfills and increasing material recovery from waste as evidenced in previous chapters.

2.3 Targets to support resource productivity and sustainable materials management

109. One policy instrument which was reviewed in detail was that of SMM related targets. „Good" targets (*i.e.*, those which are credible, supported by government and society, based on sound research and set at an appropriate level) have the potential to be effective in supporting SMM practices. The main challenge for policy makers is to understand the attributes of effective target setting, which is complicated by the multi-national aspect and complexity created by the scope of SMM, and to incorporate these attributes into their target-setting process.

110. Several OECD countries have policy objectives and targets related to resource productivity and sustainable materials management. These objectives are commonly included in national strategies and actions plans on resource efficiency, or in waste management plans. Table 1 provides an overview of selected SMM targets that are being used across the OECD and beyond.

Table 1 Sample SMM targets in selected OECD countries and regions

	Resource Extraction	Production	Resource productivity	Consumption	End of Life
Japan	Target for resource productivity with respect to earth and rock material		Targets set in the Fundamental Plan for Establishing a Sound Material-Cycle Society; to be achieved by 2020 compared to 2010: resource productivity should reach 460 thousand yens/tonne (compared to 374 thousand yens/tonne in 2010); the cyclical use input rate should reach 17% (compared to 15.3% in 2010); the final waste disposal amount should be reduced to 17 million tonnes (compared to 19 million tonnes in 2010).	Top Runner Programme provides incentives for reduced energy use from non-industrial sources through a label indicating energy performance	Targets set in the Fundamental Plan for Establishing a Sound Material-Cycle Society Programme looking at waste-related GHG emissions
Mexico	General objective to minimise use of finite resources	No specific targets, but producers of special management wastes and hazardous end-of-life products must develop specific waste management plans	General objective to increase use of recyclable and reusable materials in production		General goal to increase alternative end-of-life waste treatment (thermal/ caloric or composting) and reduce waste to landfill by 2012
Austria			Targets to increase resource productivity by at least 50 % between 2008 and 2020, and by a factor 4 to 10 in the long term (included in the 2012 Resource Efficiency Action Plan).		Waste recycling and disposal targets

	Resource Extraction	Production	Resource productivity	Consumption	End of Life
Belgium	General objective to minimise use of finite resources (Flanders)	General objective to increase number of Flemish companies producing in an eco-efficient way by 2009 (based on 2003 eco-efficiency rates)	Goal on decoupling use of natural resources from economic growth. General objective to optimise use of renewable resources (Flanders).	Increase sustainable consumption in retail and government sectors by 2015, based on 2008 levels (Flanders)	Extensive, quantifiable targets for household and industrial waste, building projects, end-of-life vehicles, tires, WEEE, batteries and oil
Canada					Ensure the proper end-of-life management of post-consumer products. Environmental objectives for waste reduction and recycling.
Czech Republic			General goal aiming at improving raw material intensity, and at promoting sustainable materials management.		
Finland	Target looking at gravel and crushed stone used in earthworks	Material efficiency criteria and related programmes in development under the waste management programme	General goal aiming at improving the efficient use of natural resources and energy taking into account the whole life-cycle.	Material efficiency criteria and related programmes in development under the waste management programme	Extensive, quantifiable targets for municipal waste, manure and building projects
France				General goal aiming at decoupling GDP growth from material consumption (draft law on the energy transition for green growth)	Waste prevention, recycling and disposal targets
Germany			Target to improve the productivity of abiotic raw materials by a factor of 2 between 1994 and 2020.		Waste recycling and disposal targets
Netherlands	Programme looking at impact on land use	Programme looking at pollution, GHG reduction and land use			Waste recycling and disposal targets
Sweden	Target for conservation of natural gravel deposits in the environmental objectives system. Follow-up of the targets is continuously reported to the government. A tax is charged for gravel extraction.		General environmental objective aiming at non-toxic and resource efficient material cycles.		Waste recycling and disposal targets
Switzerland			Long term goal to improve resource efficiency and reduce resource consumption to naturally sustainable levels.		
EU			Increase resource productivity at the same or greater rate than the 2.2% productivity improvement seen over the last 10 years. Programme is looking at developing more targets to promote resource productivity		Extensive, quantifiable time-bound targets for household waste (recycling, disposal), end-of-life vehicles, WEEE, batteries and packaging

Note: This table is based on available data, however, there are likely to be additional targets and programmes addressing the various stages defined, as well as similar practices in other OECD countries.

Source: Based on OECD (2012b), *Sustainable Materials Management: Making Better Use of Resources*, OECD Publishing; and national sources.

2.4 The role of innovation

111. Managing materials in a more efficient way, i.e. producing more with less input and less residues, requires ***innovation***, i.e. new technologies and processes. Countries were asked to which extent they link SMM with innovation policies. 76% of respondents indicated that their SMM or SMM-relevant policies are linked to technological improvements in general, and 65% to technological improvements addressing specifically waste and products. The extraction phase and the business and consumption models (e.g. replacing products by services) are adressed to a lesser extent.

2.5 Stakeholder involvement and policy integration

112. The ***involvement of stakeholders*** along the supply chain is considered as a key factor of success for SMM by most countries (see example in Box 6) and this has been formulated as one of four SMM principles (see the preceding section on 1.1 Policy principles, page 32). Stakeholder participation contributes to limit counterproductive effects by ensuring greater coherence between policies applied at each stage of the life-cycle of materials. 65% of responding countries[21] indicate that they have mechanisms to ensure collaboration between stakeholders but the remaining 35% are either not aware of such practices or do not have them in place.

113. On the related issue of the ***integration of policies*** that address materials along the life-cycle, 76% of respondents[Error! Bookmark not defined.] indicated that such integration is still limited. All respondents recognise that only modest progress has been achieved since 2007 with regard to the "vertical" integration of policies.

114. These results show that there is a ***need for significant additional efforts*** to improve communication and involvement of stakeholders throughout the supply chain (e.g. between recyclers and producers), along with the integration of different policies, be it vertically, i.e. from extraction to end-of-life of materials, or horizontally, i.e. between different activity sectors.

115. This is corroborated by a study of the European Environment Agency on resource efficiency policies in the EU, which finds that the lack of policy integration is reflected in the institutional picture: Ministries generally focus on their area of jurisdiction with only limited central or strategic coordination. Only few countries (Finland, Netherlands) seem to have an overarching mechanism to support coordination and coherence of resource productivity policies.[22] More recent initiatives, such as the EU's Resource Efficiency Roadmap and France's Circular Economy Roadmap, are likely to support better coordination across policy areas.

[21] Respondents to the 2011 SMM survey, with a total of 17 respondents.

[22] European Environment Agency (2011), Resource Efficiency in Europe – Policies and Approaches in 31 EEA Member and Cooperating Countries, Copenhagen (www.eea.europa.eu)

Box 6 The "Grenelle de l'environnement", a specific French governance initiative involving all stakeholders

In 2007, the French government identified seven critical environmental issues and organised a dialogue within French society to tackle these issues. All representatives of French society were involved: the central government, local authorities, business, unions and NGOs. They were consulted during two months through regional meetings, internet fora and parliamentary debates. As a whole about 30 000 participants divided into 7 thematic groups had the opportunity to give their opinion. Two of these topics which were discussed are more closely related to SMM: **"adopting sustainable production and consumption patterns" and "promoting sustainable development modes favoring employment and competitiveness". The discussions resulted in the adoption of 2 major environmental laws ("Grenelle 1 and 2") and fiscal measures. A follow-up Environment Conference in 2013 adopted a circular economy roadmap that identifies a set of policy measures and targets that will allow to gradually move towards a circular economy.**

Source: based on OECD (2012b), Sustainable Materials Management: Making Better Use of Resources.

3. Remaining challenges and areas for further progress

116. Gains in resource productivity over the last ten years show that encouraging progress has been achieved in terms of better management of both material resources and waste. A range of policies and initiatives have been deployed to generate these results. Experience however shows that putting in place policies that improve resource productivity and promote sustainable materials management in the long term is not an easy task.

3.1 Implementation challenges

117. A ***major challenge*** of resource productivity and sustainable materials management policies is the sheer breadth of ***scope*** that is implied by the whole of life-cycle approach. For any given material or product SMM will need to address a ***large number of economic actors*** that are active along the value chain in different sectors of the economy (e.g., miners, smelters, manufacturers, consumers, waste collectors and recyclers), as well as coordinating a number of different policy areas (e.g., agricultural, mining, product standards, fiscal, environmental). The geographic spread of actors and policies across different jurisdictions further adds to the complexity. Dealing with this situation requires a high level of ***coordination and co-operation*** between economic actors, different parts of government, and different policy areas, as well as intergovernmental co-operation to deal with transboundary issues.

118. A ***second challenge*** lies in making polices that address the life cycle of products and materials operational. This requires using multiple instruments often cutting across policy domains, rather than individual instruments or policies. When policies target specific material or product streams, the challenge lies in minimising distortions across product and material streams and in avoiding an unintended shifting of the environmental burden.

119. A ***third challenge*** lies in generating the information and the data that are needed to support RP and SMM policies and to avoid such unintended effects. In order to effectively target policies, detailed information about the type and magnitude of environmental impacts along the material life-cycle is needed (e.g. from life-cycle assessments). This needs to be complemented with data about the costs of environmental damage through economic valuation and the application of cost benefit analysis.

3.2 Implementation barriers

120. Some of the key obstacles that countries believe need to be overcome to achieve further progress in the implementation of RP and SMM policies include:

- The excessive ***compartmentalisation of policies***: this is seen as a major obstacle to the implementation of SMM, which needs to address many different actors, sectors and materials. About half of responding countries have indicated that *a coherent framework of action and policy coordination* would help to achieve further progress in this regard.
- ***Financial obstacles***: in the case of investment by enterprises in more resource efficient equipment, the issue of time delays for returns on investment compared to the need for quick returns and the frequent lack of financial resources at the level of companies, especially SMEs, have been highlighted.
- ***Mismatched time horizons***: the "short-term thinking of policy decision makers" often conflicts with the long term thinking of entrepreneurs when it comes to investment decisions.
- ***Lack of awareness of economic benefits***: further analysis demonstrating the links between economic and environmental benefits from resource/material efficiency would usefully support SMM implementation.
- ***Lack of awareness*** among policy makers, entrepreneurs and the public/consumers ***that SMM also helps address resource scarcity*** and security of supply.
- Insufficient ***internalisation of externalities***.
- ***Consumption patterns***: as an example, second-hand products, recycled products, etc. which contribute to SMM are not sufficiently valued in the market compared to new but less sustainable products. Sustainable production and consumption would benefit from economic and fiscal incentives.

3.4 The way forward

Lessons for policy makers

121. Further progress will depend on governments' capacity to better integrate policies that address materials management into a coherent policy package. Putting in place policies that improve resource productivity and promote sustainable materials management in the long term, will necessitate:

- ***Greater coherence of policies*** relating to resource use and materials management.
  A key challenge will be to ensure the coherence of policies across sectors, materials and waste streams, i.e. to ensure that policies internalise externalities in a consistent manner across the board and avoid shifting environmental impacts across borders and from one phase of the life-cycle to the other. A specific example is that of Green Procurement, where explicit attention needs to be given to the extent of internalisation of environmental costs so as to avoid that green procurement criteria are used to address environmental impacts that have already been internalised through other policies, such as a tax or an emission standard.
- ***Enhanced partnerships*** with the private sector, research, and civil society. Governments need to provide the right incentives so that business and other parts of society can make effective contributions.

- ***Inclusion of social and economic objectives***, as well as environmental ones in SMM policy making in order to stimulate and reinforce sustainable economic, environmental and social dimensions.
- ***Engagement across departmental*** divides as well as the inclusion of key SMM targets within the wider financial and budget setting process.
- ***Consideration of the full range of policy instruments and tools***. Conventional wisdom suggests that applying one policy to one addressee is the approach which is simplest to design, and most straightforward to implement. The sheer breadth of scope of SMM, which involves many different economic factors that are spread across borders, suggests that SMM action plans and programmes will need to have objectives affecting many sectors and hence, a need for more than one policy.
- ***Establishment of "good" targets*** has the potential to be effective in supporting SMM practices. "Good" targets are credible, supported by government and society, based on sound research, and set at an appropriate level based on the application of benefit-cost analysis.
- ***A good understanding of the material basis of the economy***, of international and national flows of materials and their relation to productivity and environmental risks and impacts. Material Flow Analysis (MFA), along with life-cycle analysis and other methodologies, contributes to that understanding (OECD, 2008).
- ***An international perspective*** with a common vision and differentiated solutions at the local, regional and global levels. Resource rich and exporting countries, resource poor and import dependent countries, developing and industrialised countries all have different needs. Good practices and technologies need to be shared and taken up where they are most appropriate. OECD countries have a particular responsibility in generating and disseminating good practices and technologies.

What can governments do?

122. The above calls for a range of actions from governments, including:

- Additional efforts to improve data and especially to translate life-cycle data on environmental impacts into economic costs.
- The prioritisation of material flows according to their environmental impact and the development of pilot projects that would allow to test new SMM based approaches.
- The development of innovative frameworks and processes to coordinate policies between a larger number of ministries.
- Facilitate co-operation of economic actors along the value chain (raw material producers, manufacturers, retailers, consumers, waste managers) in order to find joint solutions towards closing material cycles.
- Foster innovation and make available the necessary financial means to support technological and non-technological innovation towards SMM.
- The development of initiatives for international co-operation on specific high profile material and product streams.

What can enterprises do?

123. The transition to SMM will also require a new approach to doing business that integrates life cycle thinking in the way that enterprises operate. New business models need to be developed that focus on the

establishment of green supply chains, on finding low impact substitutes for high-impact materials, goods and services, as well as on redesigning material and value cycles in more sustainable ways. Industrial entrepreneurs ought to become life cycle managers, who assess the impacts of materials usage and seek to minimise these impacts. This should be supported with appropriate company reporting and information disclosure, and with a progressive integration of resource productivity and environmental externalities in corporate accounting.

How can the OECD assist governments in this task?

124. The OECD can and does assist governments in this task in a number of ways:

- Identifying key policy gaps and coherence issues as well as the policy measures that an SMM approach would need to undertake to address these for specific materials and products through a number of case studies on priority materials. Case studies on critical metals, wood fibre aluminium and plastics have been developed, work on construction materials is ongoing, and further work on plastics, in particular relating to marine litter, is planned.
- Analysing the benefits and the costs of SMM approaches, including the economic and administrative costs of additional planning and consultation (some of these issues will be addressed through work that focuses on resource scarcity in the framework of the Cost of Inaction and Resource Scarcity – Impacts on Long-term Economic growth (CIRCLE).
- Gathering the experiences that are being made with SMM approaches in OECD and non-OECD countries in order to develop policy guidance for SMM with a particular focus on policy instruments and mixes, as well as the governance arrangements that are required for effective coordination of policies across sectors and at the international level. Work focusing on economic policy instruments is ongoing and a review of waste prevention policies will be carried-out in 2015/16, as well as a review of obstacles and opportunities in the transition to a service-based economy and new business models (e.g. chemical leasing).

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ANNEX 1: SUMMARY TABLES

Table 2 Resource and material flow accounts in OECD countries

Type of account (a) / Country	EW-MFAcc	Individual flow accounts	Asset accounts	Other (SFA, LCA, …)	Comments
Australia	X	X	X	–	EW-MFAcc: research work. Australian Stocks and Flows Framework based on input-output approach. Individual environmental accounts (water, waste, energy, GHG, land, minerals, forests, fisheries), no full material flow analysis. Periodicity varies with projects. Monetary asset accounts since the early 1990s.
Austria	X annual	X NAMEA PIOT	X	–	Many MF studies (official and academic). EW-MFAcc: annual since 1991; under EU regulation since 2013. Physical flow Accounts and NAMEA: air (under EU regulation since 2013), materials, natural resources, nutrients, water. PIOT: work.to calculate raw material equivalents, & assess construction materials.
Belgium	X annual	X eIO-model	–	X	EW-MFAcc: under EU regulation since 2013; earlier work at regional level (Flanders since 2001, Wallonia since 2003). Extended IO model: Flanders, since 2009 (materials, emissions, waste, water, energy). Other: ad-hoc project on SFA (Flanders).
Canada	–	X	X	–	Material & Energy Flow Accounts - MEFA ; since the early 1990s; uses input-output framework. Focus on individual accounts ((raw materials, energy, water, GHG and air emissions); no EW-MFA. Varying periodicity; annual for GHG & energy accounts. Natural resource stock accounts (NRSA): Subsoil assets, timber, land; monetary and physical units
Chile	–	X	X	–	Mining, forestry, fishery accounts since 1993 (Central Bank of Chile)
Czech Republic	X annual	X NAMEA PIOT (adhoc)	–	–	EW-MFAcc: since 2000, under EU regulation since 2013. NAMEA: air (annual under EU regulation since 2013); land, energy, materials: research projects; forestry. PIOT: adhoc research projects. Other: research on indirect trade related material flows.
Denmark	X annual	X NAMEA, NRA, PIOT (pilot)	X	..	EW-MFAcc: since 1997; under EU regulation since 2013. NAMEA air (annual, under EU regulation since 2013), energy (annual). NRA: water (discontinued in 2010), balance sheets for oil, & natural gas (discontinued in 2010). PIOT: pilot project in early 2000s.
Estonia	X annual	X NRA, NAMEA	..	-	EW-MFAcc: since 2008; under EU regulation since 2013. NRA: fishery and forestry (pilot in 2003-05). NAMEA: air (annual, under EU regulation since 2013), energy. Accounts for subsoil assets, forest and water are planned, but feasibility depends on funding.
Finland	X annual	X NAMEA PIOT	..	X	EW-MFAcc: since 1997; under EU regulation since 2013. NAMEA: air (annual, under EU regulation since 2013), forest, energy. Other: sectoral LCA for mining, forest, metals, packaging industries, energy, water, waste water treatment, paper, nutrients.
France	X annual	X NRA NAMEA	..	–	EW-MFAcc: pilot-project in 2004-05, regular since 2007; under EU regulation since 2013. Includes work on hidden flows, and footprints. NRA: forest, water. NAMEA (64-industry breakdown + households): air and GHG emissions by 40 branches (annual, under EU regulation since 2013), and energy use (since 2001, prepared in parallel with air emission accounts), water abstractions (2014) and waste (postponed).
Germany	X annual	X NAMEA	–	–	Since 1993. Calculation of Raw Material Equivalents. EW-MFAcc: annual (under EU regulation since 2013). NAMEA/physical flow accounts: energy, air, raw materials, water.
Greece	X.	X NAMEA	–	..	EW-MFA under development; data for 2000-2006; under EU regulation since 2013. NAMEA: air (under EU regulation); energy (under development).
Hungary	X annual	X NAMEA	–	–	EW-MFAcc and NAMEA air: work under EU regulation since 2013. Following ad-hoc and research work in the early 2000s.
Iceland	–	X NRA	..	–	Some work on water flow accounting (link to energy) & on soil-erosion. Work in progress; link to EU regulation.
Ireland	X annual	X NAMEA	..	_	EW-MFAcc: under EU regulation since 2013. NAMEA air (under EU regulation since 2013); energy; water (adhoc work for one region in the early 2000s.)
Israel	_	X	–	_	Individual flow accounts: water. Twinning project with the EU for air and waste accounts started in 2013.
Italy	X annual	X NAMEA, PIOT (pilot)	..	_	EW-MFAcc: annual; under EU regulation since 2013 . Work on raw material equivalents. NAMEA: air (under EU regulation since 2013). Forest accounts: exploratory work.

Type of account (a) / Country	EW-MFAcc	Individual flow accounts	Asset accounts	Other (SFA, LCA, …)	Comments
Japan	X annual	X NAMEA PIOT (pilot)	–	–	MFAcc are used to monitor progress with the fundamental plan for establishing a sound material cycle society (3rd plan agreed in May 2013 by Cabinet). EW-MFAcc: annual; start in 1992; regular since 2003. Other: case studies for industrial materials. NAMEA: Environmental burden accounts linked to Economic Input-Output tables. PIOT: pilot project. Development of material flow and costs accounts.
Korea	X	X NAMEA PIOTs	–	X	EW-MFAcc: pilot project 2004-06; updates in 2007, 2011. NAMEA air (pilot-project). PIOT: feasibility study. Other: MFA of selected waste materials (paper, aluminium, wood, metals).
Luxembourg	X annual	X NAMEA	–	_	EW-MFAcc: under EU regulation since 2013. Individual flow accounts: NAMEA air (under EU regulation since 2013); energy (under development)
Mexico	..	X	..	..	EW-MFAcc: some academic work carried out in the 1990s. Individual flow accounts: System of Economic and Ecological Accounts of Mexico (SEEAM)
Netherlands	X annual	X NAMEA eIO analysis	..	X	Periodicity and status varies with projects. EW-MFAcc: under EU regulation since 2013. Includes a monitor of MF. Earlier work as part of international research project in 1997. NAMEA air (under EU regulation since 2013). Physical supply and use tables for material flows; used to support monitoring of resource policies. Other: SFA research studies since 1990; heavy metals, nutrients, organochlorines.
New Zealand	..	X NRA	..	..	NRA: Work initiated in 2001. Focus on selected resources (forestry, water, energy, minerals, fish). Broken down by industry.
Norway	X annual	X NRA, NAMEA	Energy	X	EW-MFAcc: annual, under EU regulation since 2013. SFA: hazardous substances (ad hoc work, latest in 2004). Other: NRA since 1970. NAMEA air (annual, under EU regulation since 2013), waste (annual), energy (under development). Other: SFA.
Poland	X annual	X NAMEA	–	..	EW-MFAcc: under EU regulation since 2013; annual since 2009; pilot in 2006; preliminary research study in 1998-99. MFA under legal framework for official statistics. NAMEA: air (since 2004; under EU regulation since 2013), energy (pilot)
Portugal	X annual	X NAMEA	–	–	EW-MFAcc: under EU regulation since 2013. First study in 2000. NAMEA: air (under EU regulation since 2013)
Slovak Republic	X annual	X NRA, NAMEA	–	X	EW-MFAcc: under EU regulation since 2013; pilot in 2005. NRA: since 1993; annual; water, mineral ores, energy, wood, construction materials etc. NAMEA: air (under EU regulation since 2013); energy (under development). Other: SFA.
Slovenia	X annual	X NAMEA	–	–	EW-MFAcc: under EU regulation since 2013. NAMEA: air (annual, under EU regulation since 2013); energy (under development); forest; water (planned).
Spain	X annual	X NRA, NAMEA	..	–	EW-MFAcc: annual; under EU regulation since 2013. NRA: water, forest. NAMEA air (annual, under EU regulation since 2013).
Sweden	X annual	X NAMEA	..	X	EW-MFAcc: under EU regulation since 2013. SFA: chemicals and hazardous substances. NAMEA: air (annual, under EU regulation since 2013); energy; water. Other: SFA. Ad hoc MFA on selected materials; Textiles, Electronics and Plastics
Switzerland	X annual	X NAMEA	..	X	EW-MFAcc: regular activity, annual since 2006, in-line with EU regulation. NAMEA: air (regular activity, annual since 2013, in-line with EU regulation); energy (pilot). Other: SFA.
Turkey	X annual	X NAMEA	..	_	EW-MFAcc: regular activity since 2010, link to EU regulation since 2013. NAMEA air (regular since 2010, link to EU regulation since 2003); water (pilot supply-use tables).
United Kingdom	X annual	X NAMEA, PIOT	Energy	X	EW-MFAcc: under EU regulation since 2013. NAMEA: air (under EU regulation since 2013), energy (regular); land, forestry (experimental). Other: SFA.
USA	..	X	X	X	EW-MFAcc: studies in the mid-1990s till the mid-2000s; discontinued. Other: SFA research studies on metals; Toxic release inventory (TRI); Life-cycle inventory (LCI) project; studies of key minerals.

Notes:
Overview based on country contributions to the WPEI's annual Round Table on Environmental Information, on national websites and publications, and on an earlier survey of activities related to material flow analysis. Status of activities in 2014.

a) EW-MFA: economy-wide material flow accounts or mass balances, broken down by materials and material categories; PIOTs: physical input-output tables; SFA: substance flow analysis; Individual flow accounts: NRA (natural resource accounts), NAMEA (National Accounting Matrix including Environmental Accounts), etc.

Source: OECD.

Table 3 Resource productivity and material flow indicators in OECD countries

	Type of indicator in use (a)	Included in official indicator set	Related policy plans, strategies (b)	Related objectives, targets (b)	Comments
Australia	–	–	–	–	Environmental and resource accounts are used to support the National Strategy for Ecologically Sustainable Development. Indicators are available for individual resources, not for macro-level MF or RP.
Austria	DMI, DMC, material intensity, RMC, etc.	Yes: SDI	X	X	Long term goal in the Austrian Strategy for SD and time-bound targets in resource efficiency action plan: increasing resource productivity by at least 50% between 2008 and 2020, and by a factor 4 to 10 by 2050. MF indicators part of (i) SDIs; adopted by Ministerial Council and Heads of Provinces; published first in 2004; biennial; and (ii) the indicator set "How's Austria?" prepared by Statistics Austria that measures wealth and progress. RMC: in the longer run, this indicator is expected to be included in Austria's official statistics (as soon as periodically available).
Belgium*	DMC, material intensity	Yes: SDI	X	X	Goal on decoupling use of NR from economic growth in the Federal Plan for SD. Monitoring indicators in set of SDIs.
Canada	–	–	–	–	Indicators available for selected resource and energy aspects (data from 1990), not for macro-level MF or RP.
Chile	Material productivity	Yes: GGI	X	–	MF Indicators related to Chile's green growth strategy – in line with OECD framework.
Czech Republic	DMC, material intensity, etc,	Yes	X	X	MF indicators are used to monitor green growth and assess the updated SD Strategy adopted in 2010 (goal on improving raw material intensity; objective on promoting a sustainable materials management). Published in CZE SoE reports.
Denmark	DMI, DMC, etc,	Proposed	X		Principle that "resources must be used more efficiently" in 2002 SD strategy. MF and other resource indicators last updated in 2008. New set of SDIs to monitor the current NSDS (2009) not yet developed.
Estonia	Mineral resource extraction, DMC, etc.	Yes: SDI	X	-	Mineral resource extraction: used in SDIs.; related to SD strategy.
Finland	DMI, DMC, RMC, etc.	Yes: SDI	X	X	Objective on eco-efficiency in the Government's SD Programme: improve the efficient use of natural resources and energy taking into account the whole life-cycle. New commitment to SD approved in 2013.
France	DMI, DMC, material productivity	Yes	X	–	MF indicators included in national sets of SDIs and of environmental indicators. A new SD strategy and indicators are being elaborated. It will include RP and waste management indicators to measure progress.
Germany	DMI, DMC, abiotic raw materials productivity, etc.	Yes	X	X	Objective in National SD Strategy: improving raw material productivity by a factor 2 (between 1994 and 2020). MF indicators used to monitor progress, Including demand-based indicators on raw material consumption. Resource use and efficiency indicators are also included in the German Core Set of Environmental indicators (currently under revision).
Greece	..	..	..	..	
Hungary	X	Yes	–	–	MF indicators included in sets of environmental and SD Indicators of Hungary.
Iceland	..	..	–	..	
Ireland	DMC, RMC, waste per capita	..	..	..	
Israel	..	..	–	..	
Italy	DMC, TMR, …	Yes	X	X	MF indicators included in set of "fair and sustainable welfare" indicators (Benessere Equo e Sostenibile). A target to reduce TMR (-25% by 2010; -75% by 2030; - 90% by 2050) was included in Env. Action Plan for SD approved by inter-ministerial committee in 2002.
Japan	Resource productivity, cyclical use rate, final disposal rate, DMI, DMC, …	Yes	X	X	The 3rd Fundamental Plan for Establishing a Sound Material-Cycle Society includes time-bound targets by FY2020 and a vision for FY2030. Implementation is monitored through indicators. Main indicators also included in the 4th basic environment plan of Japan.
Korea	Material intensity	–	X	–	2nd National Strategy for SD (2011-15), includes vision and implementation challenges. No targets set.
Luxembourg	..	..	..	..	
Mexico	–	–	..	..	
Netherlands	Material consumption,	..	X	X	Material consumption: for selected material groups; in set of GGIs. Recyling

	Type of indicator in use (a)	Included in official indicator set	Related policy plans, strategies (b)	Related objectives, targets (b)	Comments
	waste recycling rate, final disposal rate, …				rates and targets: National waste management plan. Final disposal rate: Waste to resource programme; targets under discussion.
New Zealand	..	..	..	..	..
Norway	–	–	–	–	Set of SDIs includes a few indicators on natural resources, but none on MF or RP.
Poland	DEU, DMC	–	–	–	Indicators used in SoE report.
Portugal	DMC per capita, GDP/DMC	Yes	–	–	Set of SD indicators; link to National Strategy for Sustainable Development. No targets set.
Slovak Republic	Material productivity, DMC, DMI, DEU, …	Yes	X	–	Links to National SD Strategy (2001); National Raw Materials Policy (2004). MF indicators in set of GGIs.
Slovenia	Material productivity, DMI, DMC,	Yes	X	–	MF indicators in set of GGIs.
Spain	DEU, DMC, TMR	Yes	..	..	MF indicators in Environmental profile of Spain.
Sweden	–	–	X	–	Sweden's environmental objectives include one aiming at non-toxic & resource-efficient material cycles. To be met within one generation, i.e. by 2020. No MF indicator in use.
Switzerland	TMR, TMR/GDP, imports	Yes	X	X	MF indicators in national system of environmental indicators and in national system of indicators to measure SD (MONET). Link to SD strategy and to Green Economy Action Plan. Long-term goal to improve resource efficiency and reduce resource consumption to naturally sustainable levels. No targets set yet.
Turkey	..	..	..	..	
United Kingdom	RMC	Yes	X	–	National set of SD indicators. Link to SD strategy (2005) and to the government's vision on mainstreaming SD (2011).
USA	DMI, DMC, TMR, …	–	–	–	Indicators published by WRI (time series); work discontinued.

Notes:
Overview based on country contributions to the WPEI's annual Round Table on Environmental Information, on national websites and publications, and on an earlier survey of activities related to material flow analysis. Status of activities in 2014.

a) DMI: Direct Material Input ; DMC: Domestic Material Consumption ; TMR: Total Material Requirement; DEU: Domestic extraction used.

b) Indicates whether goals concerning the efficient management and sustainable use of natural resources and materials exist in national sustainable development strategies, green growth strategies or environmental plans, etc. , and whether related objectives have been defined.

Source: OECD.

Table 4 Strategies, action plans and policy programmes relevant to resource productivity: country examples

	General strategies, plans and programmes integrating resource productivity issues	*Associated goals, objectives, targets*	Strategies, plans and programmes focusing on particular materials or sectors	*Associated goals, objectives, targets*
Australia	National Strategy for Ecologically Sustainable Development	..	..	..
Austria	Austrian Strategy for SD	*Long term goal on resource productivity*		
	Resource efficiency action plan (REAP) (2010)	*Medium and long term national resource efficiency targets (time-bound)*	Raw materials strategy	
	Initiative in resource efficiency and environmental technology (forthcoming, 2014)		Waste management plan	*Waste management targets*
Belgium	Federal plan for SD	*Goal on decoupling use of natural resources from economic growth*	..	..
	'Vlaanderen in Actie' (Flanders in Action, 2011)	*Sustainable Materials Management identified as one of 13 major societal challenges for Flanders*	Flanders Materials Programme (and transformation of Waste Decree into Materials Decree)	*Sustainable materials management in a green circular economy through 45 specific actions*
	Walloon SD strategy (2013)	*Goal on promoting sustainable consumption and production by 2050*	Walloon Employment Environment Alliance	*Goal on reuse of construction waste*
	Walloon Marshall Plan 2.Green Walloon Marshall Plan 2022	*Goal on a sustainable socio-economic reorganisation of the region*	Walloon Industrial policy (→ resource efficiency as a cross-cutting priority)	*Goal on fostering the competitiveness of green chemistry and sustainable materials sectors*
Canada	see Canada-wide EPR Plan.		Overarching Canada-wide Action Plan (CAP) for Extended Producer Responsibility (EPR) (developed in 2009 by the Canadian Council of Ministers of the Environment), and implementation at provincial level.	*Environmental objectives in the area of waste reductions*
Chile	Green growth strategy			
Czech Republic	Strategic framework for SD (2010)	*Goal on improving the raw-material intensity of the economy; objective on promoting a sustainable materials management*	The raw materials policy (including secondary raw materials) (under preparation)	
Denmark	SD strategy (2009)			
Estonia	Environmental tax reform 2016+	*Goal on compensating unrecoverable natural resources, which should be used more sustainably and with less ecological impact.*	National Waste Management Plan 2014–2020	*Overall goal on sustainable waste management according to waste hierarchy*
	SD Strategy (2005)	*Goal on using natural resources in ways and quantities that ensure ecological balance.*	Forestry Development Plan 2020	*Overall goal to ensure productivity and vitality, diverse and efficient use of forests*
	Environmental Strategy 2030	*Goal on sustainable use of natural resources and reduction of waste generation.*		
Finland	National material efficiency programme "sustainable growth through material efficiency"		Action plan for promoting material efficiency in construction (2014)	
	National Sustainable Consumption and Production programme (2005 "getting more from less")			
	Resolution on sustainable public procurement (2009)			
	Government decision in principle on improving sustainable environment and energy decisions in public procurement. (2013) (clean-tech focus)			

	General strategies, plans and programmes integrating resource productivity issues	*Associated goals, objectives, targets*	Strategies, plans and programmes focusing on particular materials or sectors	*Associated goals, objectives, targets*
France	SD strategy 2010-2013; Strategy for an ecological transition towards SD (forthcoming) Roadmap for a circular economy	.. ..	Waste prevention plan Waste management plan to 2025 (draft: 2014) Draft law on the energy transition for green growth	*Targets on waste generation* *Targets on waste management Objectives for EPR schemes* *Targets on waste generation by households; target on decoupling value added from waste generation by economic activities between 2010 and 2020 (including mineral wastes); recycling and disposal targets for non-hazardous and non-inert waste materials by 2025.*
			Sustainable management strategy on aggregates	*Recycling target*
Germany	Resource Efficiency programme (ProgRess)		Raw materials strategy	
	SD strategy (2002)		Waste management plan: law on circular economy	*Waste management targets*
Greece	..	..	..	..
Hungary	..	..	..	..
Iceland	..	..	..	..
Ireland	National Sustainability Strategy (2012)	*Overall goal on satisfying human needs by the efficient use of resources. Key challenges include: sustainable consumption and production; conservation and management of natural resources. (15 measures).*	National Waste Management Policy (2012)	*Goal on moving away from landfill, and towards recycling and waste prevention ((over 30 measures)*
	National Resource Efficiency Strategy (2013).	*Overall goal on improving resource efficiency. Objectives on material consumption, hazardous waste; competitiveness, growth, employment.*	Harvest 2020. Growth and Sustainability strategy for the agriculture and food sector (2010)	*Goal on increasing food production through application of green principles.*
	National Green Public Procurement Plan (2012)		National Waste Prevention Plan (2014)	*Goals on preventing waste of materials, energy & water.*
	National Environmental Research Strategy including Resource Efficiency and Raw Materials (2013)		National Hazardous Waste Management Plan (2014)	
	Government policy on Growth & Employment in the Green Economy (2012)	*Goal on fundamentally changing the way we use the Earth's finite resources (over 50 measures).*		
Israel	Green Public Procurement	*Procurement targets*	National Materials Management Strategy (forthcoming)	..
			Extended producer Responsibility schemes	*Waste recycling targets*
Italy	..	..	..	..
Japan	Fundamental Plan for Establishing a Sound Material-Cycle Society (first plan in 2002)	*Quantitative time-bound targets for resource productivity and materials management and vision for 2030*		
	Lead role in the preparation of the G8 Kobe 3R Action Plan (2008)			
	Basic environment plan of Japan			
Korea	National strategy for SD	*Vision and implementation challenges, no targets.*	..	..
Luxembourg	..	..	..	..
Mexico	..	..	..	..

	General strategies, plans and programmes integrating resource productivity issues	*Associated goals, objectives, targets*	Strategies, plans and programmes focusing on particular materials or sectors	*Associated goals, objectives, targets*
Netherlands	National Programme on Natural Resources		Waste to Resource programme (stimulates the transition to a circular economy)	*8 operational objectives in the sequence of the value chain (building upon the Netherlands Waste Prevention Programme) Targets under discussion.*
			National waste management plan Waste Prevention Programme	*Waste management targets*
New Zealand	..	..	..	..
Norway	..	..	..	..
Poland	Strategy on energy security and the environment (2014)	*Objective on the sustainable management of environmental resources, focus on sub-soil resources and supply security*	National programme for waste prevention National waste management plan	
	Strategy for innovation and economic efficiency (2013)	*Objective on the reduction of material intensity in production.*		
Portugal	Government Commitment for Green Growth (CGG) being prepared		National waste management plan	
	National strategy for SD			
Slovak Republic	Programme declaration of the Government for 2012-2016		New Waste Act Waste management programme Waste prevention programme	
	National reform programme 2014		National action plan for renewable energy	
	National action plan for green public procurement		National raw materials policy	
	Innovation strategy for 2014-2020			
Slovenia			Municipal solid waste operational plan	
Spain	Horizon 2020 programme (in oine with EU 2020 Strategy)		Energy efficiency plan	
Sweden	Sweden's environmental objectives	*Interim targets and indicators Objective aiming at non-toxic & resource-efficient material cycles.*	Waste Plan "From w*aste management to resource efficiency"*	*Waste management targets*
Switzerland	Green Economy Action Plan (2013)	*Long term goal on improving resource efficiency and reduce resource consumption to naturally sustainable levels.*		
	SD strategy 2012-2015»: «Increasing economic productivity while decoupling from resource and energy usage; aligning consumption with sustainable development. Using natural resources sustainably.			
Turkey	..	..	..	..
United Kingdom	SD strategy 92005) Government's vision on mainstreaming SD (2011)	..	..	..
	Resource security action plan			
USA	Sustainable Manufacturing Initiative (SMI)			
	Strategic (cross agency) Plan of the EPA "Working toward a sustainable future".			
	Sustainable public and private purchasing programme (and Council)	*Being developed*		

	General strategies, plans and programmes integrating resource productivity issues	*Associated goals, objectives, targets*	Strategies, plans and programmes focusing on particular materials or sectors	*Associated goals, objectives, targets*
EU	Thematic strategy on the Sustainable use of natural resources		Waste management directive	*Waste management targets (quantitative, time-bound)*
	Action plans on (i) environmental technologies, (ii) sustainable consumption and production, (iii) sustainable industrial policy.			
	Resource efficiency initiative	*Proposed target on material productivity (Eu-wide)*		
	Raw materials initiative			
	Circular economy communication and policy package			

Note:
Non exhaustive overview based on country contributions to the questionnaire on the implementation of the Recommendation of the Council on resource productivity, to WPEI's annual Round Table on Environmental Information, and on an earlier survey on sustainable materials management. Status of initiatives in 2014.

Source: OECD.

ANNEX 2: QUESTIONNAIRE ON THE IMPLEMENTATION OF THE COUNCIL RECOMMENDATION

Questions regarding the implementation of the Council Recommendation
[from document ENV/EPOC/WPRPW/WPEI(2014)1]

With a view to complementing the reporting to Council, and to help the Secretariat further refine the assessment of progress made in implementing the Recommendation, Delegates are requested to respond to the questions below. **Answers do not need to be long; most questions can be answered with a couple of concise sentences.**

Questionnaire

1.	How would you describe the level of awareness of the Recommendation in relevant authorities of your country (low, moderate, high)?
2.	What could be done in your view to raise the level of awareness of the Recommendation in your country?
3.	How would you describe the extent to which the Recommendation has been implemented by relevant authorities in your country (**fully, partially, not implemented**)?
4.	With regard to the implementation of aspects of the Recommendation related to analysis of the material flows and their environmental impacts: Please describe the analysis carried-out and provide a few examples [i.e. references to studies that analyse material flows and the associated environmental impacts and costs, measurement systems for material flows and resource productivity…]. Please provide links to supporting documentation.
5.	With regard to the implementation of aspects of the Recommendation related to policies concerning the improvement of resource productivity: Please describe the measures taken and the results achieved, and provide a few examples [i.e., references of policy documents issued by authorities (including legislation, regulations, consultation papers…) which explicitly referred to the Recommendation, acknowledged it or, if not explicitly, most likely benefited from the Recommendation)]. Please provide links to supporting documentation.
6.	How useful has the Recommendation been in supporting policy efforts to improve resource productivity and reduce negative environmental impacts of materials and product use? (very, somewhat, not at all; again, please provide a few examples).
7.	If the Recommendation has only been partially or not been implemented by relevant authorities in your country, what do you think are the reasons for this and what could be done to achieve full implementation?
8.	On the basis of your experience, would you say that the Recommendation is still relevant or should it be updated? If so, please indicate why (new challenges, any other developments…) and how (should the scope of the Recommendation be widened, should certain provisions be further elaborated, etc.)?

ANNEX 3: GLOSSARY

[from OECD (2008), "Measuring material flows and resource productivity – OECD Guide", http://www.oecd.org/environment/indicators-modelling-outlooks/MFA-Guide.pdf]

Decoupling

Decoupling refers to breaking the link between "environmental bads" and "economic goods." Decoupling occurs when the growth rate of an environmental pressure is less than that of its economic driving force over a given period. Decoupling can be either absolute or relative. Absolute decoupling is said to occur when the environmentally relevant variable is stable or decreasing while the variable reflecting the economic driving force is growing. Decoupling is said to be relative when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of the variable reflecting the economic driving force.
Source: Indicators to measure decoupling of environmental pressure from economic growth, OECD, 2002

Dematerialisation

The term "dematerialisation" has been used to reflect an absolute or relative reduction in the use of material and energy per unit of value added or output.
Source: Economy-wide material flow accounts and derived indicators – A methodological guide, Eurostat, 2001

Direct (material) flows

In material flow accounting, direct materials flows refer to flows of materials that physically cross the boundary of the economic system (*at the level for which the accounts are made, i.e. the national economy in the case of national economy-wide material flow accounts)* either as an input or as an output. Direct flows refer to the actual mass (weight) of the material or product that enters or leaves the system and do not take into account the life-cycle dimension of the production chain.
Source: OECD. (based on Eurostat 2001)

Domestic Material Consumption (DMC)

Domestic Material Consumption (DMC) is a variable used in material flow accounting. DMC measures the mass (weight) of the materials that are physically used in the consumption activities of the domestic economic system (i.e. the direct apparent consumption of materials, excluding indirect flows). In economy–wide material flow accounting DMC equals DMI minus exports, i.e. domestic extraction plus imports minus exports.
Source: OECD (based on Eurostat 2001)

Economy-wide

The term "economy-wide" is used in material flow analysis to designate MFA tools that cover the entire range of materials exchanged at the boundary of the national economy and whose results can be used to provide an aggregate overview of annual material inputs and outputs of an economy.

Hidden (material) flows

The term 'hidden flow' refers to a concept used in economy-wide material flow analysis and accounting. It is used to designate (i) the movements of unused materials associated with the extraction of raw materials from natural resources, both nationally and abroad, intended for use in the national economy; and (ii) the indirect flows of materials such as pollution or waste that occur upstream in a production process but that are not physically embodied in the product itself. The word "hidden" reflects the fact that these flows usually do not appear in traditional economic accounting. Since indirect flows are often difficult to estimate, the term "hidden flows" is sometimes used as a synonym for "unused extraction".
Source: OECD (based on Eurostat 2001)

Indirect (material) flows

The term "indirect flows" is used to designate the flows of materials that (i) are needed for the production of a product, (ii) have occurred up-stream in the production process, and (iii) are not physically embodied in the product itself. Indirect flows take into account the life-cycle dimension of the production chain, and encompass both used and unused materials.

In material flow accounting, indirect materials flows refer to flows of materials that are associated to direct flows, but that do not physically cross the boundary of the economic system (i.e. the national economy in the case of national economy-wide material flow accounts). They measure the mass (weight) of the 'cradle to border' material requirements necessary to make a product available at the border of a system either as an input or an output, minus the mass (weight) of the product itself. Such indirect flows are sometimes called "ecological rucksack".

In economy-wide material flow accounting (i.e. Eurostat, 2001) where the national economy is considered as a whole, "indirect flows" refer to upstream flows associated to imports and exports, i.e. flows that indirectly cross the boundary between the domestic economy and the rest of the world economy.

- On the input side, indirect flows are defined as the upstream material input flows that are associated to imports but are not physically imported. This includes indirect flows of used materials (i.e. the raw material equivalents of imported products minus the weight of the imported product) as well as indirect flows of unused materials (i.e. the unused extraction associated to imported products). Indirect input flows and their environmental consequences occur in countries from which the imports originate.
- On the output side, indirect flows are defined as the upstream material input flows that are associated to exports but are not physically exported. This includes indirect flows of used materials (i.e. the raw material equivalents of exported products minus the mass (weight) of the exported product itself), and indirect flows of unused materials (i.e. the unused extraction associated to exported products). Indirect output flows and their environmental consequences take place in the country for which the accounts are set up, i.e. in the domestic system.

In a PIOT framework, where the economy is further disaggregated into sub-systems (branches of production and categories of final use), the term "indirect flows" can be used to designate indirect material or product flows within the economy, i.e. upstream flows associated to deliveries that indirectly cross the boundary between branches of production and categories of final use.
Source: OECD (based on Eurostat 2001)

Life Cycle Assessment or Analysis (LCA)

A method of assessing the material requirements and potential environmental pressures of a product or a service over its entire life cycle. The life cycle generally means the time between manufacturing the product and ultimately disposing of it. The International Organisation for Standardisation (ISO), a world-wide federation of national standards bodies, has standardised this framework within the series ISO 14040 on LCA. Life cycle assessments (LCA) are based on life cycle inventories.
Source: OECD (based on Eurostat, 2001)

Life-cycle

Life-cycle is a concept used in life cycle analyses and material flow analyses to determine the environmental burden of products and services from "cradle-to-grave", i.e. from the source (raw material- or primary energy extraction) through the use phase to the "sink" (e.g. waste treatment, or recycling) and to include the materials needed for the construction, all transports and auxiliary inputs as well. The links of all processes which contribute to a life-cycle are called process chain.
Source: GEMIS Glossary, www.oeko.de

Material Flow Accounts (MFAcc)

Material flow accounts (MFAcc) are methodically organised accounts in physical units (usually in tonnes) that quantify the flows of different types of materials into, out of and possibly within a given system at different levels of detail and completeness, and by making reference to the material balance principle. They provide information on the material input from the environment into the system (e.g. resources extracted or harvested from the surrounding natural environment or imported from other systems), the transformation and use of that input in the system (from material production to final consumption) and the material outputs of the system in the form of returns to the environment as residuals (waste, pollutants) or in the form of exports to other systems.

Material flow accounts are part of environmental accounting and of the physical flow accounts family as described in the System of integrated Environmental and Economic Accounting (SEEA). An important feature of MFAcc is that they track both direct flows (i.e. flows of materials physically entering the economic process) and indirect and unused flows (i.e. flows of materials not entering the economic process, but associated to resource exploitation and to the up-stream production process of a product and of relevance from an environmental point of view).

The system to which the accounts apply is usually an economic system with its production and consumption activities, and its interactions with the surrounding environment and with other economic systems and their environment. It is these interactions that are of interest to MFAcc. The materials are recorded in physical units (usually tonnes). MFAcc can be established at various levels of scale (world regions, whole national economy, branches of production, firms, municipalities, etc.) and can be applied to materials at various levels of detail (all materials, groups of materials, individual materials or substances).

Material Flow Analysis (MFA)

Material flow analysis (MFA) refers to the monitoring and analysis of physical flows of materials into, through and out of a given system (usually the economy) through the process chains, through extraction, production, use, recycling and final disposal. MFA is generally based on methodically organised accounts in physical units (Material flow accounts). It helps identify waste of natural resources and materials in the economy which would otherwise go unnoticed in conventional economic monitoring systems.

The term MFA is used in a generic way to designate a family of tools encompassing different types of accounts, indicators and evaluation methods at different levels of ambition, detail and completeness. MFA can be applied to a wide range of economic, administrative or natural entities at various levels of scale (world regions, whole economy, industries, firms, plants, territories, cities, river basins, eco-zones, etc.) and can be applied to materials at various levels of detail (individual materials or substances, groups of materials, all materials).
Source: OECD.

Material productivity indicators

The term designates an indicator that reflects the output or value added generated per unit of materials used. This is typically a macro-economic concept that can be presented alongside labour or capital productivity.
It should be noted that the term “resource productivity” is often used to designate material productivity though the latter does not cover all resources (e.g. water is usually not included).
Source:OECD, Eurostat, 2001

Materials or material resources

The term "materials" or "material resources" designates the usable materials or substances (raw materials, energy) produced from natural resources. These usable "materials" include energy carriers (gas, oil, coal), metal ores and metals, construction minerals and other minerals, soil and biomass.

In the context of Material Flow Analysis and Accounting, the term "materials" is used in a very broad sense so as to record all material related flows at all relevant stages of the material cycle. It designates materials from renewable and non-renewable natural resource stocks that are used as material inputs into human activities and the products that embody them, as well as the residuals arising from their extraction, production and use (such as waste or pollutant emissions to air, land, water) and the ecosystem inputs required for their extraction, production and use (such as nutrients, carbon dioxide required by plants and animals for growth and the oxygen necessary for combustion).
Source: OECD.

NAMEA, National Accounting Matrix including Environmental Accounts

“National Accounting Matrix with Environmental Accounts” A matrix presentation of monetary accounts augmented by the input of natural resources, ecosystem inputs and residual outputs in physical terms. It is synonymous with hybrid supply and use tables.
Source: SEEA

Waste (solid)

The term "waste" usually stays for "solid waste". It refers to materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard. Wastes may be generated during the extraction of raw materials during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity. Are excluded:
-- Residuals directly recycled or materials directly reused at the place of generation (i.e. establishment);
-- Waste materials that are directly discharged into ambient water or air.
Source: OECD

Municipal (solid) waste

Municipal waste includes household waste and similar waste, collected by or on behalf of municipalities.

The definition also includes bulky waste (e.g. white goods, old furniture, mattresses); and yard waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste, if managed as waste.

It includes waste originating from (i) households, and from (ii) small commercial activities, small businesses, office buildings and institutions (schools, hospitals, government buildings). It may also include waste from selected municipal services, i.e. waste from park and garden maintenance, waste from street cleaning services, if managed as waste. N.B. Green waste and food waste composted on-site is not included.

It includes waste from these sources collected:

- door-to-door through traditional collection (mixed household waste), and
- fractions collected separately for recovery operations (through door-to-door collection and/or through voluntary deposits).

The definition also includes waste from the same sources and similar in nature and composition which originate from rural areas not served by a regular waste service, even if they are disposed by the generator.

The definition excludes:

- waste from municipal sewage network and treatment,
- municipal and household construction and demolition waste.

Source: OECD

APPENDIX II

Recommendation of the Council on Resource[1] Productivity[2]
Adopted on 28 March 2008 [C(2008)40]

THE COUNCIL,

HAVING REGARD to Article 5 b) of the Convention on the Organisation for Economic Co-operation and Development of 14 December 1960;

HAVING REGARD to the Recommendation of the Council of 26 May 1972 on Guiding Principles concerning International Economic Aspects of Environmental Policies [C(72)128];

HAVING REGARD to the Recommendation of the Council of 28 September 1976 on a Comprehensive Waste Management Policy [C(76)155/FINAL];

HAVING REGARD to the Recommendation of the Council of 31 January 1991 on Environmental Indicators and Information [C(90)165/FINAL];

HAVING REGARD to Decision C(2001)107/FINAL of the Council (of 14 June 2001 and 25 February 2002, as amended by C(2004)20 and C(2005)141) Concerning the Control of Transboundary Movements of Wastes Destined for Recovery Operations;

HAVING REGARD to the Recommendation of the Council of 21 April 2004 on Material Flows and Resource Productivity [C(2004)79];

HAVING REGARD to the Recommendation of the Council of 9 June 2004 on Environmentally Sound management of Waste [C(2004)100];

HAVING REGARD to the Communiqué of the OECD Council meeting at Ministerial level of 17th May 2001 which stated that "that OECD countries bear a special responsibility for leadership on sustainable development worldwide, historically and because of the weight they continue to have in the global economy and environment";

HAVING REGARD to the OECD's Environmental Strategy for the First Decade of the 21st Century endorsed by the OECD Council in May 2001;

HAVING TAKEN NOTE of OECD work on material flows and resource productivity, waste prevention and recycling, sustainable materials management, natural resource management, and trade and the environment;

HAVING TAKEN NOTE of international work on the 3Rs (Reduce, Reuse, and Recycle) steered by the G8, on sustainable resource management steered by the International Panel on Sustainable Resource Management and on energy efficiency steered by the International Energy Agency;

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1 For the purposes of this Recommendation, the term "resource" is understood to include natural resources (and the materials and products derived therefrom) whose extraction, processing, use and disposal are internationally-significant, in both economic and environmental terms. The scope of the Recommendation is limited to minerals (metallic and non-metallic industrial minerals), and biomass. Energy resources (e.g. coal, oil, gas), water resources and fishery resources are excluded and are only covered to the extent that they are part of an integrated approach to the entire resource cycle.

2 For the purposes of this Recommendation, the term "resource productivity" is 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). Energy efficiency is excluded, although it is recognised that energy efficiency and resource productivity are interrelated.

CONSIDERING the need for intensified efforts by OECD Member countries (both domestically and in the international context) to improve the productivity of natural resource use at all stages of the life-cycle of these resources (extraction, transposition, transportation, consumption, and disposal) so as to avoid waste of resources and reduce the associated negative environmental impacts;

CONSIDERING that increasing this productivity will also reduce demand pressure on natural resources more generally, thereby contributing to more secure supplies of natural resources for everyone;

TAKING INTO ACCOUNT the close co-operation on environmental matters between OECD and other international organisations;

On the proposal of the Environment Policy Committee (EPOC):

I. RECOMMENDS, with regard to the analysis of the material flows and their environmental impacts, that Member countries:

Promote resource productivity by strengthening their capacity for analysing material flows and the associated environmental impacts, and work to improve measurement systems for material flows and resource productivity, drawing on the expertise of all relevant ministries and departments of government, research and other non-governmental organisations, on OECD guidance and experience on measurement and analysis of material flows and resource productivity and on other international work; and to this effect:

1. Improve the scientific knowledge concerning the environmental impacts and costs of resource use throughout the entire life cycle of materials and the products that embody them, from natural resource extraction and manufacturing to end of life management (as wastes, reusables and recyclables), including from resources that have been imported.
2. Upgrade the extent and quality of data on material flows within and among countries and the associated environmental impacts, giving particular attention to the availability and international comparability of data on physical trade flows, including flows of recyclable materials and waste, and selected material flows that are of economic and environmental importance.
3. Work to improve and use soundly based, relevant and internationally compatible material flow accounts that track natural resource stocks and flows and link them to critical environmental cycles.
4. Further develop and promote the use of indicators for the assessment of the efficiency of material resource use, having carefully considered the uses and purposes, practical arrangements, costs, benefits and statistical basis for such indicators, including:
    - indicators to measure resource productivity and decoupling of resource use from economic growth, at relevant macro, sectoral and/or micro levels, considering both: overview indicators for monitoring natural resource use, resource productivity and the associated environmental impacts; and specific and disaggregated indicators for monitoring resource use, resource productivity, 3R (Reduce, Reuse, and Recycle) related flows and the associated environmental impacts concerning particular resources, materials or activities;
    - indicators to inform about the availability, quality and deterioration of natural resource stocks, in particular renewable resource stocks;
    - indicators to track the flows and environmental impacts of materials, taking account of their entire life cycle from natural resource extraction and manufacturing to end of life management.
5. Co-operate with non-Member Economies to strengthen their capacity for analysis of material flows and the associated environmental impacts.
6. Share OECD guidance and experience on measurement and analysis of material flows and resource productivity with all relevant ministries and departments of government, research and other non-governmental organisations, and members of the private sector.

II. RECOMMENDS, with regard to the policies concerning the improvement of resource productivity, that Member countries:

Take appropriate actions to improve resource productivity and reduce negative environmental impacts of materials and product use, by encouraging environmentally effective and economically efficient uses of natural resources and materials at the macro, sectoral and micro levels and by involving all relevant ministries and departments of government as well as research and other non-governmental organisations. To this effect:

1. Consider the use of information about material flows and their environmental impacts for planning purposes, as appropriate in a national context, including, for instance, using such information for target setting, and share these experiences and best practices with other Member countries.
2. Promote integrated life-cycle-oriented approaches, such as 3R policies (Reduce, Reuse, and Recycle), sustainable materials management and sustainable manufacturing as an input to decision-making and to increasing coherence among policies.
3. Further develop and promote the use of new technologies and innovations aimed at improving resource productivity.
4. Encourage co-operation and sharing of best practices among enterprises.
5. Contribute to the establishment of framework conditions that improve resource productivity through economic instruments.
6. Co-operate to ensure that policy measures taken to improve resource productivity are efficient in economic terms, effective in environmental terms and equitable in social terms;
7. Co-operate with non-Member Economies to strengthen their capacity for developing and implementing policies concerning the improvement of resource productivity.

III. INSTRUCTS the Environment Policy Committee:

1. To review existing policies and practices and contribute to elaborating common principles and policy guidelines on resource productivity and sustainable materials management.
2. To strengthen its capacity for material flow analysis at the international level, with particular focus on key materials, on direct and indirect flows and their environmental impacts, including possible development of relevant databases in co-operation with other international organisations and non-Member Economies.
3. To further develop and where appropriate promote the use of material flow analysis, resource productivity indicators, and methods for assessing the environmental impacts of resource use.
4. To support Member countries' efforts in developing and implementing integrated policies for managing natural resource and materials throughout their life cycles, by facilitating the exchange of experience and best practices in the field of resource productivity, including sustainable materials management and sustainable manufacturing.
5. To assist non-Member Economies in developing and implementing policy frameworks and measurement systems that contribute to the achievement of the objectives of this recommendation both domestically and internationally.
6. To carry out these tasks in co-operation with other appropriate OECD bodies, other international organisations such as UNEP (including the Resource panel) and G8 (including the 3R initiative) and the private sector.
7. To report to the Council on progress achieved in implementing this Recommendation, within five years of its adoption.