Resource Productivity in the G8 and the OECD

A Report in the Framework of the Kobe 3R Action Plan

FOREWORD

Growth is one of the major driving forces of our world's development. But to improve the well-being of our citizens in an environmentally friendly manner, we need a greener and more inclusive model of growth, especially as the size of the world economy is expected to double and world population to increase by one-third by 2030. With rising income and living standards, global consumption of fossil fuels, minerals, metals, timber and food crops is also increasing, generating pressures on natural resources and the environment.

In a "green growth world" prosperity does not need to increase the "weight of nations", *i.e.* the amount of material resources that we consume. By reducing, reusing and recycling ("the 3Rs") materials, we can decrease the need for virgin materials and improve resource efficiency. The challenge before us is to move towards a society where we create more value with less natural resource input, and where we do not compromise the needs of future generations.

Against this background, the G8 adopted during the Japanese G8 Presidency in 2008 the Kobe 3R Action Plan. In the same year, the OECD Council adopted a recommendation that encourages its members to improve resource productivity by promoting environmentally effective and economically efficient uses of natural resources and materials at the macro, sectoral and micro levels as well as to strengthen capacity for analysing material flows and the associated environmental impacts.

This report on "Resource Productivity in the G8 and the OECD", which responds to a request by G8 Environment Ministers at their meeting in Kobe in May 2008, presents an interim evaluation of progress in the last three years. It presents key trends and main policy developments related to resource productivity in OECD countries, with a particular focus on efforts to implement sustainable materials management. It identifies the main policy challenges and opportunities and discusses the steps that need to be taken to achieve further progress.

One of the major challenges outlined in the report is that the material consumption of G8 and OECD economies continues to grow, despite significant progress in improving resource productivity. The policy recommendations of the report focus on further decoupling material consumption from economic growth by better integrated policies. Such a coherent set of policies should take into account the full life-cycle of materials and better information on the environmental impacts and costs of resource use and for tracking materials flows. The OECD continues to offer our support to governments and other stakeholders on both these fronts through the identification and dissemination of good practices.

Angel Gurria

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EXECUTIVE SUMMARY

Going for green growth and establishing a resource efficient economy is a major environmental, development and macroeconomic challenge today. In this context, improving resource productivity and putting in place policies that ensure a sustainable waste and materials management building on the principle of the 3Rs is crucial. Better resource productivity can help both to improve the environment, by reducing the amount of resources that human economic activity requires as well as diminishing the associated environmental impacts, and to improve resource security and competitiveness.

This report responds to the request by G8 Environment Ministers asking the OECD to "…follow up on the progress of work related to resource productivity", and to deliver a report to the G8 Environment Ministers Meeting in 2011 or "whenever such reporting is appropriate" (2008 Kobe 3R Action Plan).

The report includes an interim evaluation of progress. It presents key trends and main policy developments related to resource productivity in OECD countries, with a particular focus on efforts for sustainable materials management. It identifies the main policy challenges and opportunities and discusses the steps that need to be taken to achieve further progress.

The report provides the following key messages:

- Global extraction of material resources continues to grow, but there are signs of decoupling from global economic growth. G8 countries' resource productivity has been improving , their material intensity decreased by more than 47% between 1980 and 2008 and their annual per capita material consumption declined from nearly 20 tonnes to less than 18 tonnes. Over the same period, OECD economies have reduced their material intensity by 42% and their per capita consumption declined by 1.5% to 17.6 t.
- However, the overall level of material consumption has continued to grow in parallel with economic growth, albeit at a slower rate. This means that decoupling has been happening only in relative, rather than absolute, terms. And despite the decline witnessed over the 1980-2008 period – a trend partly attributable to the 2008 financial crisis – per capita consumption in G8 and OECD countries remains at high levels and is about three times that of the rest of the world.
- Within the G8, Canada, Germany, Italy and Japan have succeeded in decoupling material consumption from economic growth in absolute terms. Some absolute decoupling has occurred across all G8 countries for certain material groups, such as wood, construction minerals, industrial minerals and metals, the latter experiencing the strongest decoupling.
- If indirect material flows associated with trade are taken into account, i.e. material flows that are not incorporated into traded products such as materials for resource extraction and processing, progress in countries that are net resource importers is more modest.
- While G8 countries offer a mixed picture on total annual waste generation, with some countries showing a decrease and others an increase, a generally positive trend can be observed in municipal waste management (representing roughly 10% of total waste). Per capita municipal solid waste has decreased by almost 4% over the past ten years in the OECD, while GDP continued to grow. Also, recycling rates have been continuously 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 these materials.
- Well designed environmental and material policies support resource productivity by reducing pressures on virgin materials, and by promoting efficient use of materials in circulation. A combination of policies has been used to achieve the positive trends in materials consumption and waste management, including eco-design, information policies, as well as a range of waste policies inspired by the "Reduce, Reuse, Recycle" (3Rs) philosophy. But there is broad recognition that further progress can only be achieved through more integrated policy approaches that take account of the full life-cycle of materials and are designed according to the principles of Sustainable Materials Management developed by the OECD. All G8 and most OECD countries are now experimenting with this new policy approach in their domestic materials policy

frameworks. Some of the key challenges are linked to the transboundary dimension and complexity of most supply chains and the large number of economic actors that need to be involved in such policies.

- OECD countries will need to make significant additional efforts to further improve the resource productivity of their economies. This will involve both further efforts to scale-up and improve existing policy approaches and to make them more coherent and better integrated. This includes policies that regulate the trade of certain wastes or affect trade in raw materials. The development of practical guidance on sustainable materials management policies and the production of more and better data would help to support those efforts. In particular, further work is needed to improve the understanding of environmental impacts and costs of resource use throughout the life-cycle of materials and products that embody them (i.e. from natural resource extraction, manufacturing, use/consumption to end-of-life management). This will also require the development of compatible databases for key material flows, the further development of material flow and resource productivity indicators, and the sharing of good practices within countries, among countries and among enterprises.

Only three years have passed since G8 Environment Ministers adopted the Kobe 3R Action Plan and this report should be seen as a first assessment of the progress that has been achieved to date. The OECD will prepare further evaluations of progress in resource productivity, in the framework of its Council Recommendation on Resource Productivity, in the coming years, and continue to provide analysis, data and recommendations to support countries in furthering their efforts to improve resource productivity.

INTRODUCTION

This report responds to the request by G8 Environment Ministers asking the OECD to "...follow up on the progress of work related to resource productivity", and to deliver a report to the G8 Environment Ministers Meeting in 2011 or "whenever such reporting is appropriate" (2008 Kobe 3R Action Plan).

The report includes an interim evaluation of progress. It draws from recent OECD work on waste and sustainable materials management and builds on work on measuring material flows and resource productivity carried out as part of the implementation of the OECD Council Recommendation on Resource Productivity. It uses information from the OECD material flows database and key environmental indicators, and preliminary results from a survey of sustainable materials management practices in OECD member countries (carried out in March 2011).

It presents key trends and main policy developments related to resource productivity in OECD countries, with a particular focus on efforts for sustainable materials management. It identifies the main policy challenges and opportunities and discusses the steps that need to be taken to achieve further progress.

A complete evaluation of progress with work related to resource productivity will be prepared for 2013, in the framework of reporting on OECD's Council Recommendation on Resource Productivity.

POLICY CONTEXT

THE ISSUES

Going for green growth and establishing a resource efficient economy is a major environmental, development and macroeconomic challenge today. In this context, improving resource productivity and putting in place policies that ensure sustainable waste and materials management building on the principle of the 3Rs is crucial. Better resource productivity can help both to improve the environment, by reducing the amount of resources that human economic activity requires as well as diminishing the associated environmental impacts, and to improve resource security and competitiveness.

POLICIES AND ACTIONS

National initiatives

Many ***countries*** have included resource productivity issues in their sustainable development strategies or environmental plans, have established programmes on sustainable production and consumption, stewardship programmes for materials and natural resources, and have introduced integrated waste and materials management policies such as sustainable materials management (SMM) or circular economy approaches.[1] While differing as regards their level of ambition and their specific focus, these programmes and policies all share (i) the need to move towards policies and measures that build on an integrated approach to natural resource and materials management, such as SMM, and that consider the full resource cycle; (ii) the need for greater efficiency in the way natural resources and materials are used in the economy; (iii) the recognition that a life cycle approach is needed to maximise the net benefits from natural resource and materials use.

Business sector initiatives

Many ***business sectors*** address these issues by establishing stewardship programmes for materials and products, investing in R&D and using advanced technologies to increase materials and energy efficiency, enhancing environmental management, promoting eco-design and coherent materials supply and use systems.

[1] For instance, some EU Member States are in the process of developing national strategies or action plans on resource efficiency, such as the Resource Efficiency Action Plan in Austria.

International initiatives

Many ***international initiatives*** promote greater resource productivity and a sustainable materials management; and encourage international cooperation in these areas. The 3R initiative (Reduce, Reuse, and Recycle) endorsed by the Heads of State and Government of ***G8 countries*** in 2004 (Sea Island Summit) and the Kobe 3R Action Plan adopted in 2008 are prominent examples of such initiatives.

Resource productivity issues are also being addressed by ***UNEP*** and the ***European Commission***. Examples include:

- The International Panel on Sustainable Resource Management, established by UNEP in 2007 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 EU Thematic strategy on the sustainable use of natural resources (adopted in 2005), complemented with a strategy on the prevention and recycling of waste, integrated product policies (IPP) and an Environmental Technology Action plan.
- The EU Raw Materials Initiative (November 2008) and Strategy (February 2011) that 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 EU has also developed new criteria to distinguish secondary raw materials from waste so as to create greater legal certainty and a level playing field for the recycling sector.

This is further supported by international efforts to promote good *governance in the raw materials sector* and to make the management of natural resource rents more transparent (e.g. the Extractive Industries Transparency Initiative); and by international efforts to promote sustainable consumption and production (SCP) such as the 10-year framework of programmes on SCP being under discussion by the UN Commission on Sustainable Development.

OECD work

OECD countries are committed to improve resource productivity and have signed up to two ***OECD Council recommendations*** in 2004 and 2008 to this effect[2]. The first one was to improve information on material flows and resource productivity. The second one to analyse material flows and the associated environmental impacts, to promote the use of resource productivity indicators, and to develop and implement policies to improve resource productivity and reduce negative environmental impacts of materials and product use.

Improving resource productivity is also a central element in the move towards ***green growth*** and OECD's efforts to develop a Green Growth Strategy.

[2] OECD (2008), Recommendation of the Council on Resource Productivity [C(2008)40], Paris; OECD (2004), Recommendation of the Council on Material Flows and Resource Productivity [C(2004)79], Paris.

INFORMATION BASIS AND DATA QUALITY

This report presents recent trends on resource productivity and sustainable materials management in G8 and OECD member countries. It primarily relies on the OECD database on material flows and on OECD environmental data, and on the results of a survey of sustainable materials management practices in OECD countries that was carried out in March 2011.

It has to be noted that, due to information gaps, not all OECD or G8 countries are systematically covered, and that country aggregates may include estimates or refer to partial totals:

- The survey of sustainable materials management practices covers 16 OECD countries, including 7 out of 8 G8 countries.

- The OECD material flow dataset covers the period 1980-2008, all 34 OECD countries and the BRIICS countries[3]. The focus is on material resources, i.e. metals and metal ores, construction minerals, industrial minerals, energy carriers (oil, coal, gas), and biomass (food, feed, wood). Water as a natural resource is excluded. (see *Glossary*). It builds on and expands Eurostat's economy-wide material flows database, and makes use of various other international and national sources (e.g. UN COMTRADE, U.S. Geological Survey, FAO). The data coverage and completeness vary by variable and from country to country; gaps remain in particular for the 1980s up to the 1990s for the former centrally-planned economies in Southeast and Eastern Europe, and for emerging economies, including Russia. Although a considerable amount of work has been carried out in the past decade to set up material flow accounts, missing information, including on physical flows of international trade, and a lack of consensus on conversion factors limits the calculation of some material flow indicators at international level. The most significant gaps concern indirect and unused flows of materials and flows of secondary/recycled materials.

- Gaps in information on waste flows and their management constrain the tracking of progress with resource productivity and the 3Rs. These gaps stem from a number of issues, including different definitions of waste across countries and inconsistent or non-existent tracking and reporting of waste streams. The waste data used here are part of the OECD core set of environmental data; they have been updated based on country replies to the 2010 OECD questionnaire on the state of the environment, and on other national and international sources, including Eurostat and UNSD. Where there were gaps in the data series, efforts have been undertaken to estimate data points in between.

The data presented in this report reflect the impact of the 2008 global financial crisis on resource use and material consumption. In most G8 and OECD countries, the economic slowdown caused material extraction and consumption to level off or decrease (sometimes significantly) in 2008. This should be taken into consideration when reviewing and interpreting the trends in resource productivity outlined in this report. The 2013 report on progress with the implementation of the OECD Council's Recommendation on Resource Productivity will provide a more complete assessment.

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3 Database established further to the adoption in 2004 of the OECD Council Recommendation on material flows and resource productivity. Original calculations made by the Wuppertal Institute on behalf of the OECD. Eurostat conventions for establishing direct material flows accounts have been followed. Unused material flows were calculated based on the Wuppertal's database of coefficients developed with the Sustainable Resources Europe Institute (SERI) as part of the EU-funded projects EXIOPOL and INDI-LINK.

KEY TRENDS IN RESOURCE PRODUCTIVITY IN THE G8 AND THE OECD

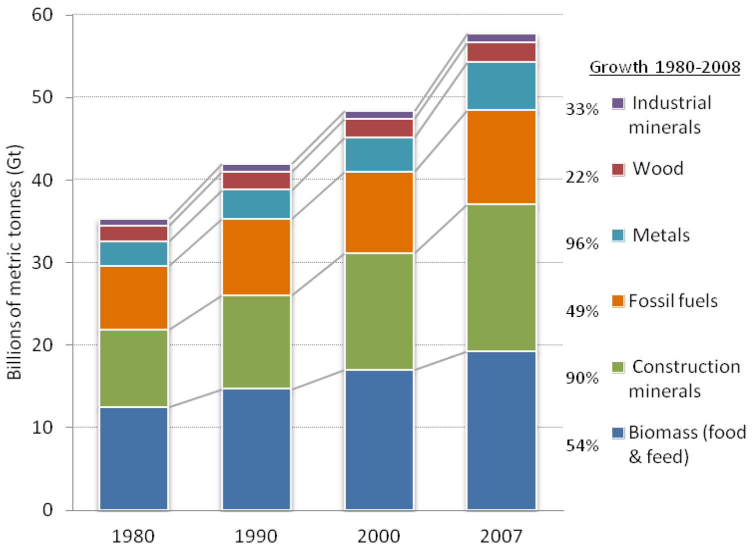
MATERIAL EXTRACTION AND CONSUMPTION

Global extraction of material resources continues to grow

The total volume of material resources extracted or harvested worldwide reached nearly 60 billion metric tonnes (Gt) per year in 2007, a 65% increase from 1980 and an estimated 8-fold increase over the last century when material extraction was less than 7 Gt per year (Krausmann, F. et al. 2009). Global extraction is estimated to remain around the 60 Gt level today because there has been limited economic growth since the 2008 financial crisis. As the economic recovery takes hold, growth in global extraction is expected to return, with one projection expecting it to reach 100 Gt by 2030.[4]

Materials related to food and agriculture account for the largest share of global extraction, but their dominance has been declining over the last century reflecting the shift from an agrarian- to an industrially-based global economy. Once accounting for an estimated 75% of material resources extracted, biomass accounts for less than 40% of global extraction today (Krausmann, F. et al. 2009). Non-renewable resource extraction has grown to over 60% of global extraction with construction minerals making up almost 30% of extracted materials in 2007, fossil fuels[5] 20%, and metal and metal ores 8%. Industrial minerals accounted for less than 2% of the extraction.

Figure 1: Global extraction of material resources, Growth 1980-2007



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

[5] The term "fossil fuels" refers to the raw materials (energy carriers) from which fossil fuels and other petroleum-based products are derived.

Material extraction increases by two-thirds when unused materials are considered

Along with 60 Gt of materials that were extracted for use in the economy in 2007, 40 Gt of materials were extracted, but not used further. These materials, referred to as unused (domestic) extraction (UDE), include mining overburden, harvest residues and fisheries by-catch. Unused extraction is important, particularly for some materials; it accounts for over 70% of the total extraction associated with fossil energy and around half for metals and industrial minerals, but only 10% or less for biomass and construction minerals. The total volume of unused materials has grown at a slower rate than used extraction (40% growth compared to 64% between 1980 and 2007). Improvements in extraction and production processes, as well as changes in the composition of global extraction have contributed to this trend.

DECOUPLING

There are signs of a relative decoupling in resource extraction from global economic growth

While growing in absolute terms, progress continues to be made in decoupling resource extraction and material consumption from economic growth. Today fewer material resources are being used and consumed to produce each dollar of GDP.[6] From 1980 to 2007 the material intensity of the global economy decreased from around 1.3 kg per USD (constant 2005 PPP) to just over 0.9 kg/USD. If unused materials are included, intensity decreased from 2.4 kg to 1.5 kg per USD over the same time period.

> **What is material intensity?** Material intensity refers to the effectiveness with which an economy uses materials extracted from natural resources to generate economic value added (e.g. the amount of raw materials, in kilograms, required to generate one unit of GDP, in dollars). In this report material intensity is measured as domestic material consumption (DMC) per unit of GDP.
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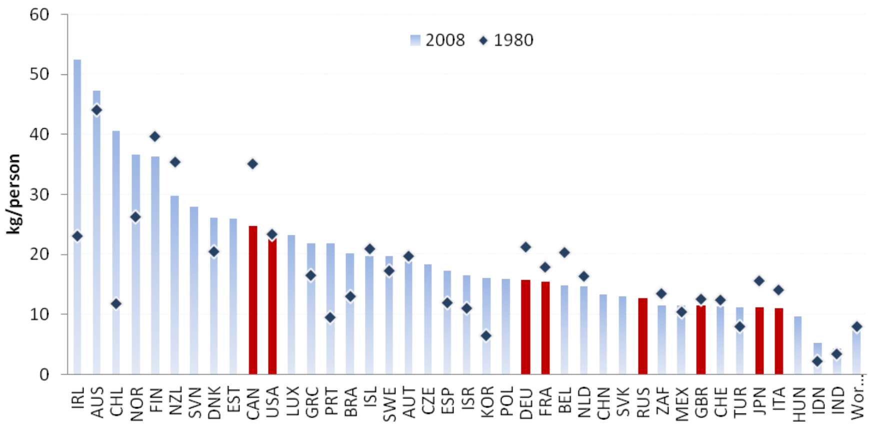
> **Decoupling** is breaking the link between "environmental bads" and "economic goods". Absolute decoupling occurs when environmental impacts are decreasing while the economy is expanding. Decoupling is relative when environmental impacts are growing, but at a slower rate than the economy. See *Glossary*.

Until the early 2000's global per capita material consumption remained fairly stable – around 8 t per person per year. Accelerating material extraction beginning in 2003, driven primarily by rapid economic growth in emerging economies (the BRIICS: Brazil, Russia, India, Indonesia, China and South Africa), saw per capita consumption rise to nearly 9 t per year by the end of 2007.

Figure 2: Per capita domestic material consumption (DMC), OECD and BRIICS countries, 1980-2008



[6] At the global level, total extraction is equivalent to total consumption. The terms are used interchangeably when describing global trends in resource productivity.

G8 countries are leading efficiency gains, but consumption remains relatively high

In 2008, G8 countries consumed 13 Gt of material resources (or roughly a quarter of all of the materials consumed around the world), an increase of 7.4% relative to 1980 when over 12 Gt were consumed. [7] Growth was mainly driven by increased consumption of construction minerals, biomass for food and agriculture, and fossil fuels. Together these materials dominate the materials mix in G8 countries, accounting for almost 90% of material consumption.

Although G8 countries continue to consume more materials, growth in consumption has been slower than in OECD countries.[8] Between 1980 and 2008 material consumption in OECD countries increased by over 20% - from 16 Gt to nearly 20 Gt. The material mix in OECD economies closely mirrors that of G8 economies, with construction minerals accounting for the largest share of consumption, followed by fossil fuels and biomass for food and agriculture.

> While the objective of decoupling material consumption from economic growth seems straight forward, it also reflects a simplification of a complex reality. Improving resource productivity, i.e. reducing the amount of resources used per unit of economic output, is assumed to lead to a parallel reduction of environmental impacts and help to avoid resource scarcity, but achieving relative or absolute decoupling of the use of a given resource may not always be a policy priority. In some cases, resources may be abundant and their use may not generate noticeable environmental impacts, eg the use of water for agricultural irrigation in water rich regions. Also, there may be cases where it may be desirable to increase the use of a specific resource that has a small environmental impact, in order to be able to reduce the use of another, environmentally more harmful resource. In other cases, the technologies or practices needed to achieve further progress in reducing resource use may outweigh the benefits. The objective of decoupling resource use from economic growth therefore should not be misunderstood as a universal policy goal, but rather requires careful analysis on a case by case basis.

Notwithstanding continued growth in the level of material consumption, inroads have been made in improving resource productivity in both G8 and OECD countries. Between 1980 and 2008 the material intensity[9] of the G8 economies decreased by over 47% while in OECD countries material intensity declined by 42%.

Over the past decade, per capita consumption had begun to stabilise around 20 t per person per year in G8 countries and around 19 t per person per year in OECD countries. In 2008, the economic slowdown from the global financial crisis saw per capita consumption drop to under 18 t in G8 countries. Based on these estimates, an average person living in a G8 country consumes roughly 50 kg of materials per day, including 10 kg of biomass, 20 kg of construction minerals, and 15 kg of fossil fuels. This is 2.5 times more than an average person in a non-G8 country, and slightly more than an average person in an OECD country.

The stabilisation in per capita consumption witnessed in G8 and OECD countries points to the existence of a threshold level of income (around 25 000 USD per year) beyond which per capita consumption stops increasing or even decreases, provided that adequate policies are put in place.[10]

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7 Due to gaps in data prior to 1995, references to the G8 do not include Russia unless otherwise indicated. Including Russia, domestic material consumption (DMC) in G8 countries was around 14.8 Gt in 2008, which is on par with estimated consumption levels in 1995. (Material consumption in G8 countries rose steadily from 1995, reaching a peak in 2006, but returned to 1995 levels in 2008 following the financial crisis).

8 Due to gaps in data prior to 1995, references to OECD countries do not include the Czech Republic, Chile, Estonia, Israel, Hungary, Poland, the Slovak Republic or Slovenia, unless otherwise indicated.

9 In this context material intensity is measured as domestic material consumption (DMC) relative to gross domestic product (GDP).

10 Several studies have suggested that the intensity of use of a mineral (the use of a mineral commodity divided by GDP) depends on the level of economic development as measured by GDP per capita, and that the pattern of intensity of use follows an inverse U-shape as economies develop. As development takes place, countries focus on building infrastructure (such as rails, roads, and bridges, housing and other buildings and water supply and electricity transmission) and people buy more durable goods, which rapidly increases the demand for mineral commodities. As economies mature, all other things being equal, they move to a less materials-intensive phase, spending more on education and other services, which reduces the intensity of minerals use (Malenbaum, W. 1975; Altenpohl, D.G. 1980; Tilton, J.E. 1990).

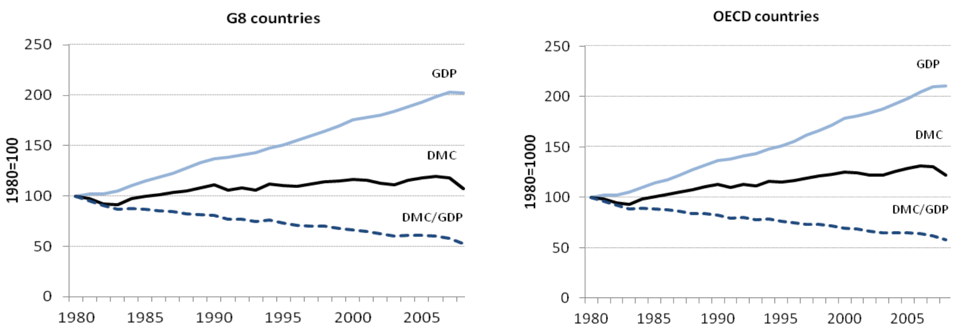
The largest gains have been made in recent years

Since 1980 ***relative decoupling*** has occurred across all G8 countries. Canada, Germany, Italy and Japan have experienced an absolute decrease in the level of material consumption. Consumption remained relatively flat in France and the United Kingdom, while it continued to grow in the United States. In per capita terms, consumption decreased or remained flat in all G8 countries with the strongest gains made in Japan, Germany, Italy and Canada, respectively. However, there have been significant improvements since 2000. With the exception of biomass for food and agriculture and fossil fuels, absolute decoupling has taken place in all material groups, with wood, metals and industrial minerals experiencing the strongest decoupling.[11]

The **rebound effect**: resource decoupling rests on the assumption that the same or greater output can be achieved with fewer inputs, ie that any innovation that results in better resource productivity will contribute to decoupling. In practice, however, this may not be true due to the rebound effect. If a commodity is made cheaper because it has been produced with less resources this may result in increased demand for this commodity. While the rebound effect has been well studied at the micro level and its effects were found to be limited (rebounds from 0 to 40%), questions remain in terms of its effects at the macro-economic level. (UNEP (2011a))

Similar trends can be observed in the OECD. Countries there also experienced relative decoupling across all material groups over the 1980-2008 period, with only a couple of instances of absolute decoupling. As with the G8 countries, the largest improvements in material productivity have been made since 2000. Consumption of all material groups except biomass for food and feed and fossil fuels decreased between 2000 and 2008.

Figure 3: G8 and OECD material consumption versus GDP



Source: OECD material flow database, OECD Economic Outlook and World Bank.
Notes: G8 figures do not include Russia.
OECD figures do not include: Chile, Czech Republic, Estonia, Hungary, Poland, Slovak Republic, Slovenia and Israel.

INDIRECT FLOWS AND DECOUPLING

Reliance on material imports is increasing

As a whole, G8 countries are net importers of material resources and have been for decades despite including resource-rich, export-oriented member countries such as Canada and Russia. In 2008 material exports by G8 countries (including Russia) totalled 3.1 Gt while imports reached almost 3.9 Gt, including over 2 Gt of fossil fuel imports, resulting in a physical trade balance of around 800 Mt (net imports).[12] The pattern is closely mirrored in OECD countries, where imports of fossil fuels drove a physical trade balance of over 1.6 Gt of net imports in 2008.[13]

While domestic extraction is decreasing, material imports are increasing and

[11] This trend holds when Russia is included in 2000-2008 figures.
[12] If Russia is excluded, the physical trade balance of G7 countries in 2008 is 1.4 Gt (3.7 Gt of imports and 2.3 Gt of exports).
[13] Figures include the Czech Republic, Chile, Estonia, Israel, Hungary, Poland, the Slovak Republic and Slovenia. Excluding these countries leaves the physical trade balance largely unchanged.

making up a growing share of consumption in both G8 and OECD economies. In 1996 less than 20% of consumption was met by material imports in G8 countries, by 2008 this share had risen close to 29%. A similar increase was witnessed in OECD countries. Increasing imports of material resources are important in the context of measuring resource productivity because semi-finished or finished products weigh significantly less than the raw materials from which they are derived (e.g. iron ore versus steel). As a result, declining material consumption cannot be completely attributed to efficiency gains; some improvements are likely to be a reflection of increased substitution of domestic production by imports, or in other words due to a shift of manufacturing from G8 and OECD economies to developing or emerging economies.

Progress is moderate once indirect flows are considered

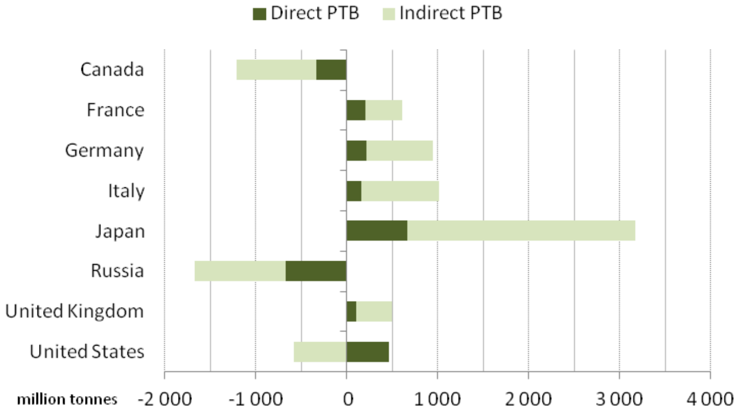
Once the indirect flows associated with trade are taken into account, the material requirements of a country can expand significantly. Systematic estimates of indirect trade flows are available for only some G8 and OECD member countries, but illustrate that the magnitude of these flows is significant. For example, the G8 countries' physical trade balance of 800 Mt in 2008 grows to over 2.4 Gt once indirect flows are included due to the volume of indirect flows associated with fossil fuels and metals.

Accounting for hidden flows is important because they can reduce gains that have been made in reducing direct material consumption. For example, Japan is one of the leading countries in the G8 and OECD in terms of resource productivity and is one of only a handful of countries where the consumption of material resources had decoupled from economic growth in absolute terms even prior to the 2008 financial crisis. Between 1980 and 2008, Japanese material consumption decreased by over 20% while the economy expanded by 96%. When including unused domestic extraction and estimated indirect flows from trade, the decrease in material consumption appears more modest - 1% between 1980 and 2008. Similarly, in Germany domestic material consumption decreased by over 10% between 1996 and 2008, but accounting for unused extraction and indirect flows cuts this progress in half.[14]

What are indirect flows? Two types of material flows are embodied in goods – direct flows and indirect flows. Direct flows are the materials that make up the components of a product (e.g. plastic in cell phones). Indirect flows are the flows of materials associated with the extraction and processing of the raw materials required to make a product. They include both material inputs to production (used materials) and materials that remain unused in the environment, such as mining overburden or harvest residues. These materials are not physically imported and usually remain in the producing country. Indirect flows are sometimes referred to as "ecological rucksacks" and together with unused domestic extraction make up the **hidden flows** associated with the production and consumption of materials.

[14] See note about data limitations, especially for the calculation of unused extraction and indirect flows in the section « Information Basis and Data Quality ». Data on indirect flows was calculated based on methodologies outlined in Dittrich et al. (forthcoming).

Figure 4: Physical trade balance (PTB) in material resources, G8 countries 2008



WASTE GENERATION AND RECOVERY

About one fifth of annual resource extraction ends up as waste

Global annual waste generation is currently estimated at about 12 billion metric tonnes per year, of which G8 countries produce roughly half and the OECD countries about one third. This means that every year the equivalent of about one fifth of global material extraction (60 Gt) ends-up as waste[15], while the rest is emitted to the atmosphere (e.g. through the combustion of fossil fuel) or being added to economies material stock in the form of infrastructure, investment and consumer goods.

Table 1: Estimated total waste generation

Estimated Global Waste Generation	
G8 countries	over 6 billion tonnes
BRIICS (excl. RUS)	over 4.5 billion tonnes
OECD countries (excl. G7)	~ 1.2 billion tonnes
Other EU countries	~ 0.7 billion tonnes
Global waste generation	**> 12 billion tonnes per year**

Source: OECD environmental data, UNSD, Chalmin & Gaillochet (2009) and national sources.

The trends in total waste generation over the last decade are rather diverse where data are available. Whereas there is a 10-20% decrease of total waste generation in Germany and the UK, the trend was flat in Japan and there was a 30% increase in Italy.

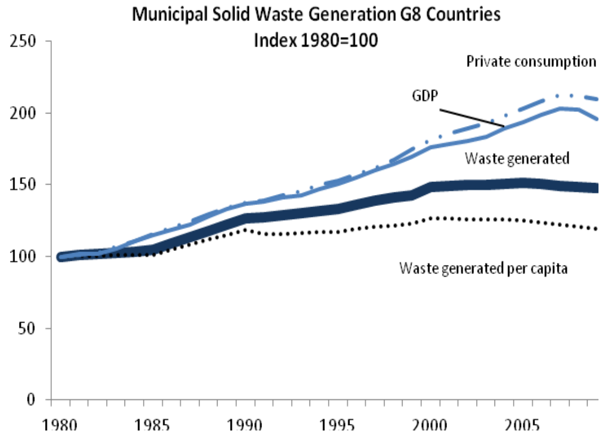
In most countries, construction and demolition waste represents the lion's share of waste (e.g. 79% in France, 54% in Germany), followed by waste from manufacturing, municipal sources and water management and treatment (between 10-30% each depending on the country).

15 It is important to note that some process residuals may be totally benign while others may be a concern for the environment or human health. Equally, some residuals may have economic value and could theoretically be recovered.

Per capita municipal solid waste has been decreasing slightly in the past decade, despite strong economic growth

The fraction of waste for which there is the best data is municipal solid waste (approximately 10% of total waste generation). Over the last two decades, G8 countries, and more generally OECD member countries, have put significant efforts into curbing municipal solid waste generation, and this is now starting to show results. For the first time in modern history, the amounts generated seem to have stabilised and per capita generation shows a downward trend: between 2000-2009 it decreased by about 2.7% in the G8, and by 3.5% in the OECD area, while GDP continued to grow.

Figure 5: Municipal Waste Generation versus GDP, G8 countries, 1980-2009



While some of the municipal waste reduction is probably attributable to the economic and financial crises which has constrained household consumption, this positive trend is mostly due to the significant efforts to better manage municipal waste that OECD countries have been deploying over the past decades.

Recycling rates have continuously increased for a number of high volume materials, but remain very low for many high value materials

In parallel, more and more waste is being diverted from land-fills and incinerators and fed back into the economy through recycling. Virtually all OECD countries have developed ambitious recycling policies, resulting in many high-volume materials (such as glass, paper and steel) featuring recycling rates well above 50%. In some countries and for some materials collection rates for recycling approach 95%, such as for glass where Belgium, the Netherlands and Switzerland exceed 90%. In almost all OECD countries recycling rates have increased considerably over the last decade. This is also visible in the share of municipal waste that is being recycled, which has increased from 21% in 1995 to 36% in 2009 in the G8 (Figure 6).[16]

While recycling rates have reached very high levels for some of the ferrous and non-ferrous metals, there are a lot of precious or specialty metals[17] that are not recycled or for which recycling rates remain very low. The UNEP International Panel on Resources estimates that out of 60 surveyed metals, only 18 are currently recycled at rates above 50%, and 36 metals have recycling rates of less than 10%, leaving significant scope for further progress in this area (UNEP 2011).

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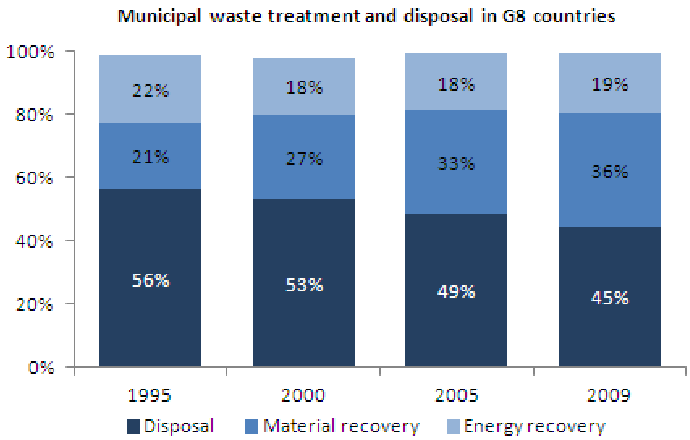
16 It should be noted that the economic feasibility of recycling depends on population density, distance to markets and transportation costs of secondary materials. Countries where these factors are unfavourable, will therefore usually display lower levels of recycling.

17 Ferrous metals are: Fe, Cr, Mn, V, Ni, Nb, Mo; Non-ferrous metals: Mg, Al, Ti, Co, Cu, Zn, Sn, Pb; Precious metals: Ru, Rh, Pd, Ag, Os, Ir, Pt, Au; Specialty metals: Li, Be, B, Sc, Ga, Ge, As, Se, Sr, Y, Zr, Cd, In, Sb, Te, Cs, Ba, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Hg, Tl.

Figure 6: Treatment of municipal waste, G8 countries, 1995-2009



KEY TRENDS IN POLICY MAKING FOR SUSTAINABLE MATERIALS MANAGEMENT

ACHIEVING RESOURCE PRODUCTIVITY THROUGH SUSTAINABLE MATERIALS MANAGEMENT

Resource productivity is the goal, sustainable materials management the policy concept that can help to achieve it

Resource productivity is tied to the production and use of materials and the subsequent generation of waste. These two aspects of resource productivity are two sides of the same coin. They share many of the same driving forces — the materials we use and the resulting wastes are closely linked to how we produce and consume goods. The massive international trade in material resources and, on a much smaller scale, the trade in waste both require life-cycle thinking and a global perspective to take into account burden shifting across borders. Full-cost resource pricing, promoting resource efficiency and innovation, ensuring policy coherence and closing resource use and waste loops are just some of the common threads of both policy areas.

G8 countries have recognised resource productivity as an important area of policy action and adopted the Kobe 3R Action Plan at a meeting of Environment Ministers in 2008 in Kobe, Japan. The objective of this action plan is to reduce the environmental and health impacts of resource use, to boost jobs and innovation, and to respond to the advancing interdependence of the world economy and resulting resource constraints from increasing demand. G8 countries have been following-up on the plan through a series of initiatives, including Japan's support for the Regional 3R Forum in Asia, which is providing an important platform for cooperation between countries in the region, and the EU's current efforts at developing a strategy for a resource efficient Europe that will set-out how resource productivity targets can be set and achieved.

The OECD has been supporting efforts to improve resource productivity in its member countries by adopting a Council Recommendation on Resource Productivity[18] and introducing the concept of Sustainable Materials Management (SMM).

SMM elevates the focus of governments, industry and consumers from individual material, product or process attributes, to the entire system of material flows and associated life-cycle impacts. 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.*"[19] SMM covers a large array of policies that are relevant to achieving better resource productivity.

Historically, governments have focused on managing waste as a means of managing the impact of materials on the environment. While much success has been achieved with waste management policies, research has shown that waste management is often not the key process, nor is it the most efficient and effective process, for controlling material flows in the industrial and economic systems.

The implementation of SMM policies and practices therefore is a promising strategy for improving resource productivity and to decouple economic growth from natural resource consumption. Sustainable Materials Management therefore constitutes an important component of any green growth strategy. Improving resource productivity will also indirectly reduce demand pressures on natural resources and therefore contribute to better resource security.

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18 OECD (2008), Recommendation of the Council on Resource Productivity [C(2008)40], Paris.

19 OECD working definition.

THE BENEFITS OF BETTER RESOURCE PRODUCTIVITY ARE SIGNIFICANT

Sustainable materials management produces significant benefits

Reduce life-cycle environmental impacts and improve policy coherence

Better management of materials helps to minimise environmental impacts by reducing the release of toxic substances to the environment and by limiting human exposure. It also helps to reduce pressures on resources by diminishing the quantities of materials that need to be extracted. Beyond this, the whole life cycle approach that is embodied in SMM can help to reduce overall life-cycle environmental impacts by addressing policy incoherence where it exists. 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. Yet, this may lead to an overall negative effect on the environment as some life-cycle studies suggest. In a one litre bottle of milk, for instance, the milk generates about five times as much CO2 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).

SMM can help to reduce dependency on raw materials

Concerns about access to resources have gained importance on the political agenda, since prices for many resources have been taking steep increases and producing countries have sometimes restricted the export of certain resources. Sustainable materials management can help to reduce these pressures by 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 trough reuse or recycling.

In Japan, a set of policy measures in line with the 3Rs, Reduce, Reuse, Recycle philosophy that supports the implementation of the "Fundamental Law for Establishment of a Sound Material Cycle Society" have helped to increase the cyclical use rate of material. This rate compares recovered resources to total material input, of the Japanese economy and has improved by 41% since 2000, reaching 14.1% in 2008. As a result of this and other efforts, Japanese material intensity was 37% below the OECD average in 2005.

Improved competitiveness at no or low cost

More sustainable and efficient management of materials also helps to improve competitiveness by reducing input costs. In the UK, 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 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 (22 billion) in waste reduction and material management (DEFRA, 2011).

One global clothing firm identified waste in its shoe manufacturing process cost it 550 million euro 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

Measures that help to increase the productivity of resources can generate innovation and new and additional economic activity in areas such as waste collection and treatment or recycling, potentially creating growth and jobs.

In the EU core environmental industries active in the fields of pollution management and control, waste collection and treatment, renewable energy and recycling have a combined turnover of over 300 billion euro; provide nearly 3.5 million jobs, and have impressive global market shares of 30-40%. This sector is growing at annual rates of more than 8% in a global market predicted to reach four trillion euro by the middle of the decade and is offering many new and skilled green jobs.

MAIN CHALLENGES

Improving resource productivity through sustainable materials management requires integrated life-cycle based policies for waste, materials and products, such as circular economy or 3R related initiatives, integrated *supply chain management*, and the use of instruments aimed at stimulating technological change. It also implies internalising the costs of waste management into prices of consumer goods and of waste management services; and ensuring greater cost-effectiveness and full public involvement in designing measures.

Putting in place policies that promote sustainable materials management and improve resource productivity in the long term, necessitates:

Policy coherence

- greater coherence of policies relating to resource use and materials management (e.g. economic and trade policies, investment policies, technology and innovation policies, natural resource policies, environment policies).

Partnerships and incentives

- 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.

Information and material flow 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. *Material Flow Analysis* (MFA), along with life-cycle analysis and other methodologies, contributes to that understanding.

Framework conditions

- shared *policy principles* and guidelines to overcome barriers to increased resource efficiency, and related *framework conditions* to secure resource productivity and guide investment choices.

International perspective

- an international perspective with a *common vision and differentiated solutions* at the local, regional and global levels. Many developing countries have specific needs. Resource rich and exporting countries have specific needs. Resource poor and import dependent countries have specific needs. Good practices and technologies need to be shared and taken up where they are needed. *OECD and G8 countries* have a particular responsibility here.

KEY TRENDS IN SUSTAINABLE MATERIALS MANAGEMENT POLICIES

Trends in resource productivity over the last twenty years show that encouraging progress has been achieved in terms of better management of both material resources and waste. A range of policies and separate initiatives has been deployed to generate these results, and it has become clear that further progress will crucially depend on governments' capacity to better integrate policies that address materials management into a coherent package.

This section of the report presents the progress that G8[20] and OECD countries have achieved in developing and implementing sustainable material management policies. The chapter summarises the results of a survey on SMM policies that was conducted among OECD member countries in March 2011[21] and seeks to identify the key policy trends since the previous survey in 2007.

The concept of SMM is increasingly reflected in environmental policies of G8[22] and OECD countries

There is an increasing uptake of the sustainable materials management concept in policies and resource strategies

The awareness of the sustainable materials management policy concept as a driving mechanism for improving resource producivity, and its translation into policies and programmes, has been increasing over the past 4 years. Two out of seven G8 countries report that they have a national SMM definition. More generally, the number of OECD countries that report that they have such a definition has doubled to 50% since the previous survey in 2007. Also, 5 out of 7 G8 countries and 50% of OECD countries now have policies that are specifically addressing SMM.

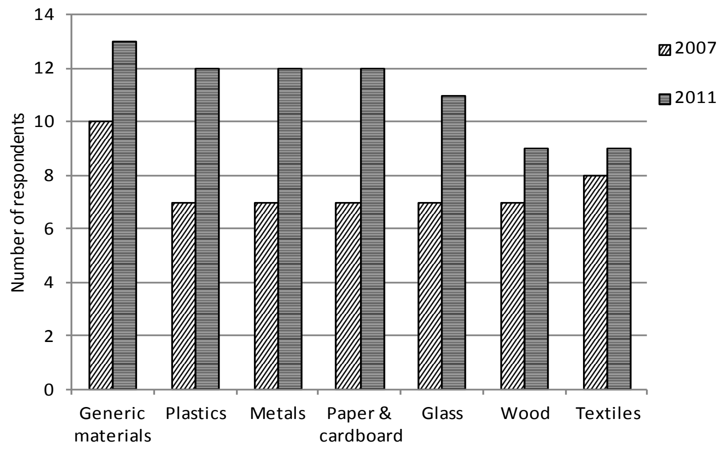
The focus of SMM policies is multifaceted

The scope and coverage of SMM policies is increasing

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 (Figure 7).

Figure 7: SMM policies/programmes addressing materials



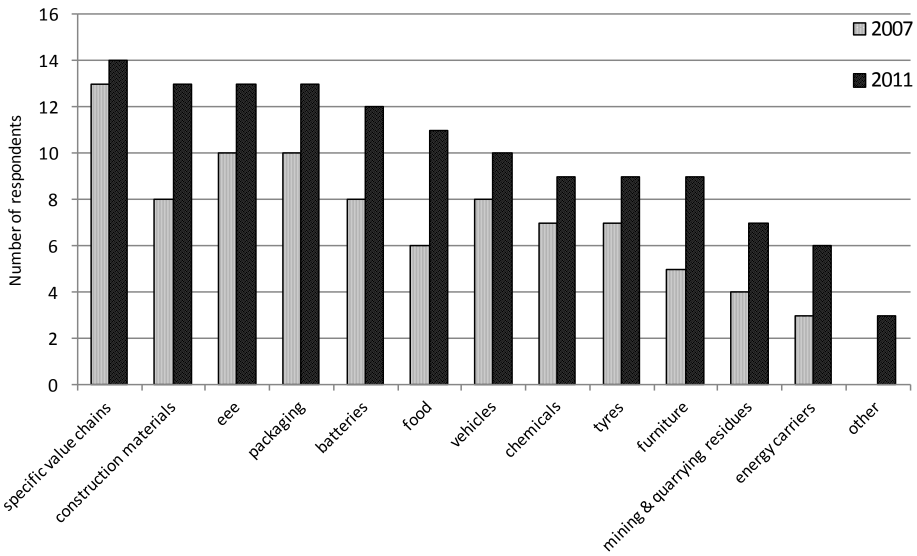
[20] The survey of sustainable materials management policies that was conducted for this chapter does not include Russia.

[21] 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.

[22] The survey of sustainable materials management policies that was conducted for this chapter does not include Russia.

Concerning specific product categories, (Figure 8) 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 8: SMM policies/programmes addressing product categories



Responses demonstrate that both types of approaches whether they target materials (Figure 7) or product categories (Figure 8) co-exist and complement each other; only one approach would not be sufficient to achieve full SMM.

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.

Since only a few countries responded on whether they have SMM policies targeting specific stages of the life-cycle of materials, it is possible that countries have turned their attention to products instead of focusing on the up-stream activities of material production such as resource extraction. Considering the global nature of production processes, the approach that is most practical at this time for countries is to focus on the stages of the life-cycle which are within national boundaries or most easily measured. These are manufacturing and provision of services. A minority of respondents (Austria, Canada, the US and the EC) have developed policies that seek to address several/all stages of the materials life-cycle.

Box 1. 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.

A wide range of policy instruments is used to support SMM

Policy makers are making use of a broad set of policy instruments to implement SMM policies

A broad variety of policy instruments are being used to implement SMM. Dematerialisation[23] and detoxification[24] are the most commonly used approaches in achieving progress toward SMM: 94% and 82% of respondents, 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 typically used within waste management policies, have 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 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[25] or the Stockholm Convention for Persitent organic pollutants). In many cases, regulations are complemented by information-based instruments (especially destined for SMEs), and partnership programmes.

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).

In general a majority of countries (mainly European countries and Japan) seem to favour legally binding instruments to implement SMM policies, whereas in a few countries such as the US, the United Kingdom and Canada, a mix of regulatory and

[23] "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.

[24] "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)

[25] REACH is the EUs policy for the Registration, Evaluation, Authorisation and registration of Chemicals.

market-based approaches is used to implement SMM policies. Some voluntary, market-based initiatives related to products that involve industry and other stakeholders have also been reported as successful such as the Electronic Products Environmental Assessment Tool (EPEAT) in the US and the Chemical Leasing in Austria (Box 2).

The success of SMM requires innovation and policy integration

However, SMM policies remain insufficiently integrated across stages of the material life-cycle and between different sectors

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.

Box 2. 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.

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 1) and this has been formulated as one of four SMM principles (see the following chapter). 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 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.

On the related issue of the integration of policies that address materials along the life-cycle, 76% of respondents indicated that such integration is still limited in 2011. All respondents recognise that only modest progress has been achieved since 2007 with regard to the "vertical" integration of policies.

Clearly, there is still 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.

This finding from the OECD survey is corroborated by a recent 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.[26]

[26] "Initial findings from the analysis of draft national reports on resource efficiency policies and instruments" - interim project report, 2011 EEA survey of resource efficiency policies in member and cooperating countries, March 2011. EEA report forthcoming in the Summer 2011.

Box 3. 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.

Challenges in implementing SMM policies

A number of obstacles need to be overcome to achieve further progress

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

- The excessive compartmentalisation of policies is 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, Finland has highlighted the issue of time delay for investment returns compared to the need for quick returns and the United Kingdom has mentioned the frequent lack of financial resources for companies, especially SMEs.
- Mismatched time horizons: one country mentioned the "short-term thinking of policy decision makers" which conflicts with the long term thinking of entrepreneurs when it comes to investment decision-making.
- Lack of awareness on economic benefits: further analysis demonstrating the links between economic and environmental benefits from resource/material efficiency would usefully support SMM implementation.
- Insufficient internalisation of externalities is cited by Austria, Poland, Sweden and the European Commission as a major obstacle for the implementation of SMM.
- Consumption patterns are considered barriers to SMM: 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.
- A lack of awareness about SMM as a tool to address resource scarcity among policy makers, entrepreneurs and the public/consumers, was mentioned by Netherlands, Slovenia, the UK and the EC.

OECD GUIDANCE ON SUSTAINABLE MATERIALS MANAGEMENT – WHERE DO WE STAND?

OECD has started to develop policy guidance for SMM

Work to develop practical guidance for policy makers who wish to improve the resource productivity of their economies and put in place sustainable materials management policies is currently ongoing at the OECD. This work has been carried-out through a number of reports, workshops and events, most recently a Global Forum on Sustainable Materials Management held in October 2010 in Mechelen, Belgium. These efforts have resulted in a number of policy papers and materials case studies.[27] The following summarises the main conclusions of this work to date.

SMM POLICY PRINCIPLES

There are four key principles of SMM

Recent OECD work suggests that four broad SMM Policy Principles should be used as guidance for the development of SMM policies wherever possible.

Principle 1 - Preserve natural capital

SMM can contribute to the preservation of natural capital, on which humans depend, and which is needed to foster long-term sustainability. Policy Principle 1 envisions leveraging the best available science, engineering, business and management practices to encourage the preservation of natural capital. 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. Strategies for SMM Policy Principle 1 include:

- Improving information about materials, their flows and environmental impacts;
- Increasing resource productivity and resource efficiency;
- Reducing material throughput, particularly of high impact materials;
- Increasing reuse/recycling of materials to preserve natural capital; and
- Advancing 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

It is at the design stage that decisions are made that determine impacts throughout the life cycle. SMM Policy Principle 2 calls for maximising positive (and minimising negative) impacts to the environment and human health and well-being through design. By managing for safety and sustainability at each life-cycle stage, efforts are made to ensure that risks are not shifted from one stage in the value chain, or from one geographical region, to another. Economic and social outcomes are optimised while natural capital is preserved and materials are sustainably managed. SMM Policy Principle 2 also calls for increased cooperation between actors across the life-cycle so that all actors are aware of the impacts of their actions and decisions on other phases of the life-cycle and can act accordingly.
Three overarching material, product and process design strategies support SMM. Specifically these are detoxification, dematerialisation, and design for value recovery.

[27] www.oecd.org/environment/gfenv

Principle 3 - Use the full suite of policy instruments to stimulate and reinforce sustainable economic, environmental and social outcomes

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

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

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

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

KEY LESSONS FOR POLICY MAKING

...and a number of important policy lessons

While experience with SMM policies is still limited, a number of insights have been emerging from recent work:

- 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 actors 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. Recent experience with SMM policies in OECD member countries suggests that policy makers should consider the full range of policy instruments and tools.

- A key challenge will be to ensure the coherence of these 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.

- SMM policies need to have regard to social and economic issues, as well as environmental ones in order to stimulate and reinforce sustainable economic, environmental and social dimensions.

- To support the integration of SMM policies within the wider economic context, policy makers need to engage across departmental divides as well as including key SMM targets within the wider financial and budget setting process.

- The use of market based instruments, specifically, measures designed to internalise environmental (and social) costs, is likely to attract more attention. These will also have an effect on consumption through their influence on demand.

- A review of seven examples of SMM policies carried-out in the OECD shows that voluntary approaches of various sorts appear to be a popular policy instrument to implement SMM policy objectives. This may be linked to the fact that these instruments are well adapted to addressing a large range of economic actors, as well as having the potential of affecting economic actors beyond national borders.
- There are limitations in the extent to which best policies can be applied at present. In order to overcome some of these, it is recommended that a more focused effort is made to ensure that more work is undertaken to make stronger links between impacts identified as important in life-cycle assessment, and the valuation of these through economic techniques.
- One policy instrument which was reviewed in detail was that of SMM related targets. That research suggested that ‘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 locally appropriate target-setting processes.

NEXT STEPS

Considerable progress in resource productivity has been achieved in recent years, but more is needed to effectively decouple the use of material resources from economic growth. This will require both better policies and better data.

BETTER POLICIES

OECD countries will need to make significant additional efforts to further improve the resource productivity of their economies. This will involve, both further efforts to scale-up existing policy approaches, developing innovative approaches and ensuring that policies are more coherent and better integrated. It requires efforts in technological innovation, trade policies, international cooperation and capacity development, as set-out in the Kobe G8 3R Action Plan.

The OECD can support these efforts through the development of further practical guidance on sustainable materials management policies, i.e. based on the identification and dissemination of good practices and by developing an operational SMM toolkit. For this, it will be helpful to develop case studies on priority materials that clearly identify the policy challenges and the measures that can help to meet those challenges.

More links could also be established and reinforced between the OECD’s work on SMM and other international initiatives directly or indirectly related to materials management, such as the UNEP Resource Panel, the UN Commission on Sustainable Development’s 10 Year Programmes on Sustainable Consumption and Production, the Commission on Sustainable Development, and the UNEP SETAC Life Cycle Initiative.

BETTER KNOWLEDGE AND INFORMATION

A considerable amount of work on material flow analysis (MFA) has been carried out in the past decade, much of it focusing on the development of methodologies and the necessary "spade work" to set up accounts required for calculating material flow (MF) indicators and carrying out the analysis. About two-thirds of OECD countries have now developed MFA initiatives, mostly focussing on their economically and environmentally most important resources and materials. Recent efforts in Europe aim at promoting the implementation of economy-wide MF accounts in EU countries and at establishing mandatory reporting.

This is supported with international efforts led by the UN to develop a System for integrated environmental economic accounting. Countries are also increasingly interested in monitoring progress with regard to resource productivity and sustainable use of resources/materials on the basis of indicators and quantitative objectives or targets. (e.g. Finland, Japan, Netherlands, Sweden).

Further work is needed to improve the understanding of environmental impacts and costs of resource use throughout the lifecycle of materials and products that embody them (i.e. from natural resource extraction, manufacturing, use/consumption to end-of-life management). Required also are the implementation of compatible databases for key material flows, the further development of MF and resource productivity indicators, and the sharing of good practices within countries, among countries and among enterprises. Important gaps remain with respect to:

- Material flows of importance to the 3R initiative, including flows of recyclable materials and secondary raw materials, and flows of waste, and trade flows by origin and destination.
- Material flows that do not enter the economy as transactions, but that are relevant from an environmental point of view, including unused materials and indirect flows.

More work is also needed to:

- Develop methods to assess the environmental impacts of materials use
- Provide industry-level and material-specific information to indicate opportunities for improved performance and efficiency gains.
- Identify a balanced set of indicators for use in international work and that countries can adapt to suit their own needs and circumstances.

Continued efforts are being undertaken by the OECD to assist in the further development and use of MF and RP data and indicators, both in OECD work and in OECD member countries, and to promote the exchange of related experience with non members. This is done in collaboration with UNEP and its Resource Panel, Eurostat and several research institutes.

As reported by several countries in the SMM survey (e.g. Finland, Japan, Netherlands, Sweden) an effective way to achieve SMM is to audit or monitor progress with regard to resource productivity and sustainable use of resources/materials on the basis of indicators and quantitative objectives or targets.

NOTES

Country aggregates

OECD Europe	This zone includes all European member countries of the OECD, *i.e.* Austria, Belgium, the Czech Republic, Denmark, Estonia*, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia*, Spain, Sweden, Switzerland, Turkey and the United Kingdom.
OECD	This zone includes all member countries of OECD, *i.e.* countries of OECD Europe plus Australia, Canada, Chile*, Israel*, Japan, Mexico, New Zealand, the Republic of Korea and the United States.
BRIICS	Brazil, the Russian Federation, India, Indonesia, China and South Africa.
G8	Canada, France, Germany, Italy, Japan, the Russian Federation, the United Kingdom and the United States.

* Chile became a member of the OECD on 7 May 2010; Slovenia on 21 July 2010; Estonia on 9 December 2010; and Israel on 7 September 2010.

Country aggregates may include Secretariat estimates.

Cut-off date

This report is based on information and data available up to the mid-March 2011.

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Wuppertal Institute for Climate, Energy and the Environment, www.wupperinst.org.

ANNEX 1: GLOSSARY

Decoupling

The term decoupling refers to breaking the link between "**environmental bads**" and "**economic goods**."

In practice, the **measurement** of decoupling refers to the relative growth rates of a direct pressure on the environment and of an economically relevant variable to which it is causally linked. Decoupling occurs when the growth rate of the environmental pressure (EP) is less than that of its economic driving force (DF) over a given period. One distinguishes between **absolute and relative** decoupling. Decoupling is said to be absolute when the environmental variable is stable or decreasing while the economic variable is growing. Decoupling is said to be relative when environmental variable is increasing, but at a lower rate than the economic variable.

The decoupling concept has however no automatic link to the environment's capacity to sustain, absorb or resist pressures of various kinds (deposition, discharges, harvests). A meaningful **interpretation** of the relationship of EP to economic DF will require additional information. Also, the relationship between economic DF and EP, more often than not, is complex. Most DF have multiple environmental effects, and most EP are generated by multiple DF, which, in turn, are affected by societal responses. Changes in decoupling may thus be **decomposed** in a number of intermediate steps. These may include changes in the scale of the economy, in consumption patterns, and in economic structure — including the extent to which demand is satisfied by domestic production or by imports. Other mechanisms in the causal chain include the adoption of cleaner technology, the use of higher quality inputs, and the post facto clean up of pollution and treatment of waste.

Source: OECD (2002) Indicators to measure decoupling of environmental pressure from economic growth; OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

Direct (material) flows

In material flow accounting, direct material 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 (2008) Measuring material flows and resource productivity: The OECD Guide.

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 (2008) Measuring material flows and resource productivity: The OECD Guide.

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 material 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".

Source: OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

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 (2008) Measuring material flows and resource productivity: The OECD Guide.

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. This definition does not include water as a resource.

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 (2008) Measuring material flows and resource productivity: The OECD Guide.

Natural resources

Natural resources are part of natural capital. They include stocks of mineral and energy resources, soil resources, water resources, and biological resources. Natural resources are characterised by **three features** that distinguish them from other types of capital:

- Natural resources are not produced.
- If depleted or degraded their natural stocks cannot easily be replaced or restored.
- They form an integral part of larger ecosystems, and their depletion and degradation can lead to environmental degradation and reduced ecosystem services.

Natural resources are commonly divided into **non-renewable and renewable** resources:

- **Non-renewable** natural resources are exhaustible natural resources whose natural stocks cannot be regenerated after exploitation or that can only be regenerated or replenished by natural cycles that are relatively slow at human scale. Examples include metals and other minerals such as industrial and construction minerals, and fossil energy carriers, such as oil.
- **Renewable** natural resources are natural resources that, after exploitation, can return to their previous natural stock levels by natural processes of growth or replenishment. Conditionally renewable resources are those whose exploitation eventually reaches a level beyond which regeneration will become impossible at human scale (e.g. clear-cutting of tropical forests). Examples include timber from forest resources, freshwater resources, land resources, wildlife resources such as fish, agricultural resources.

Source: OECD (2008), Measuring material flows and resource productivity – OECD guide; based on OECD (2001) Sustainable development – Critical issues, Chapter 10. Natural Resource Management, OECD, Paris; and on United Nations et al. (2003), Integrated Environmental and Economic Accounting 2003- Handbook on national accounting, New York.

Physical Trade Balance (PTB)

Physical Trade Balance (PTB) is a variable used in material flow accounting. It measures the physical trade surplus or deficit of an economy. In economy-wide material flow accounting, PTB equals imports minus exports. Physical trade balances may also be calculated for indirect flows associated to Imports and Exports.
Source: OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

Productivity

Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use. While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals that there is neither a unique purpose for measuring productivity nor a single measure.

The terms productivity and efficiency refer to different but related concepts. Productivity relates the quantity of output produced to one or more inputs used in the production of the output, irrespective of the efficiency of their use.
Source: Measuring Productivity - OECD Manual: Measurement of Aggregate and Industry-Level Productivity Growth, OECD, Paris, 2001. [http://www.oecd.org/dataoecd/59/29/2352458.pdf].

Resource productivity

Resource productivity refers to the effectiveness with which an economy or a production process is using natural resources. It can be defined with respect to:

(i) the economic-physical efficiency, i.e. the money value added of outputs per mass unit of resource inputs used. This is also the focus when the aim is to decouple value added and resource consumption.

(ii) the physical or technical efficiency, i.e. the amount of resources input required to produce a unit of output, both expressed in physical terms (e.g. iron ore inputs for crude steel production or raw material inputs for the production of a computer, a car, batteries). The focus is on maximising the output with a given set of inputs and a given technology or on minimising the inputs for a given output.

(iii) the economic efficiency, i.e. the money value of outputs relative to the money value of inputs. The focus is on minimising resource input costs.

The term also designates an indicator that reflects the output or value added generated per unit of resources used. This is typically a macro-economic concept that can be presented alongside labour or capital productivity. Resource productivity would ideally encompass all natural resources and ecosystem inputs that are used as factors of production in the economy. The term is however often used as a synonym for material productivity.

Material productivity

Material productivity makes reference to the effectiveness with which an economy or a production process is using materials extracted from natural resources.

The term also 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 (2008) Measuring material flows and resource productivity: The OECD Guide, Eurostat, 2001.

Total Material Consumption (TMC)

Total Material Consumption (TMC) is a variable used in material flow accounting. TMC measures the total mass (weight) of materials that are associated to the (apparent) material consumption of the domestic economic system, whatever their origin is (domestic, rest of the world). In economy-wide material flow accounting TMC equals DMC plus unused extraction plus indirect flows associated with imports minus indirect flows associated with exports.

Source: OECD OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

Unused extraction

In material flow accounting, unused extraction refers to materials that originate from the environment, but do not physically enter the economic system as input for further processing or consumption and return to the environment as residuals immediately after removal/displacement from their natural site. They are not incorporated in products at any stage and are usually without economic value.

It includes materials that (i) are extracted, moved or disturbed by economic activities on purpose and by means of technology, (ii) are not fit or not intended for use in further processing, and (iii) remain unused in the environment. This is the case when material must be extracted from the natural environment, along with the desired material, to obtain the desired material, or when material is moved or disturbed to obtain the natural resource, or to create and maintain an infrastructure.

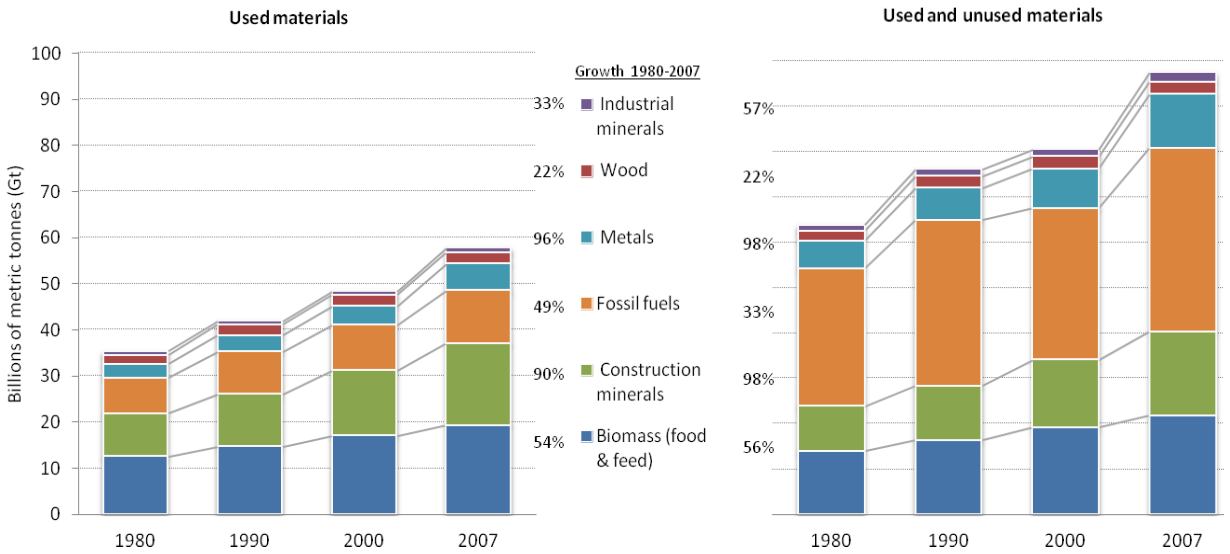
Examples of unused extraction are soil and rock excavated during construction and not used elsewhere, dredged sediments from harbours, overburden from mining and quarrying and unused biomass from harvest.

Source: OECD (2008) Measuring material flows and resource productivity: The OECD Guide.

ANNEX 2: FIGURES AND TABLES

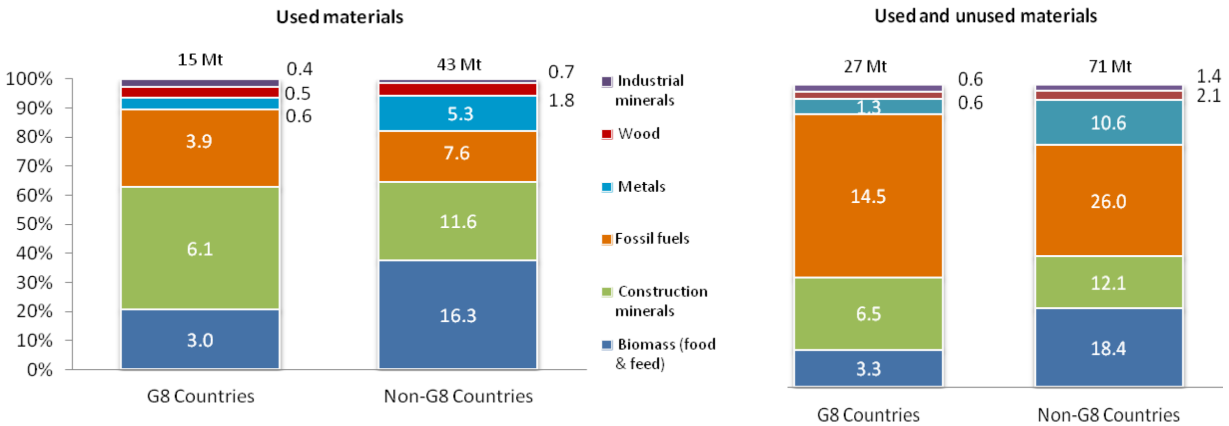
TRENDS IN GLOBAL EXTRACTION

Global Extraction of Material Resources, 1980-2007



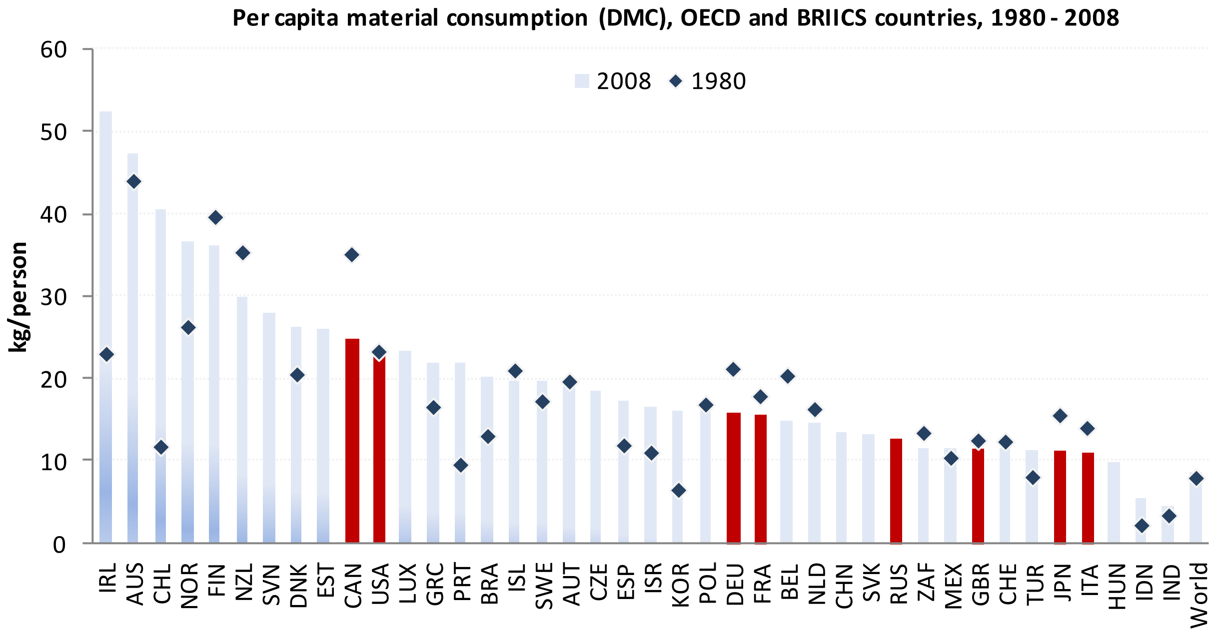
Source: SERI (Sustainable Europe Resource Institute).

Composition of Material Extraction, G8 and non-G8 countries, 2007

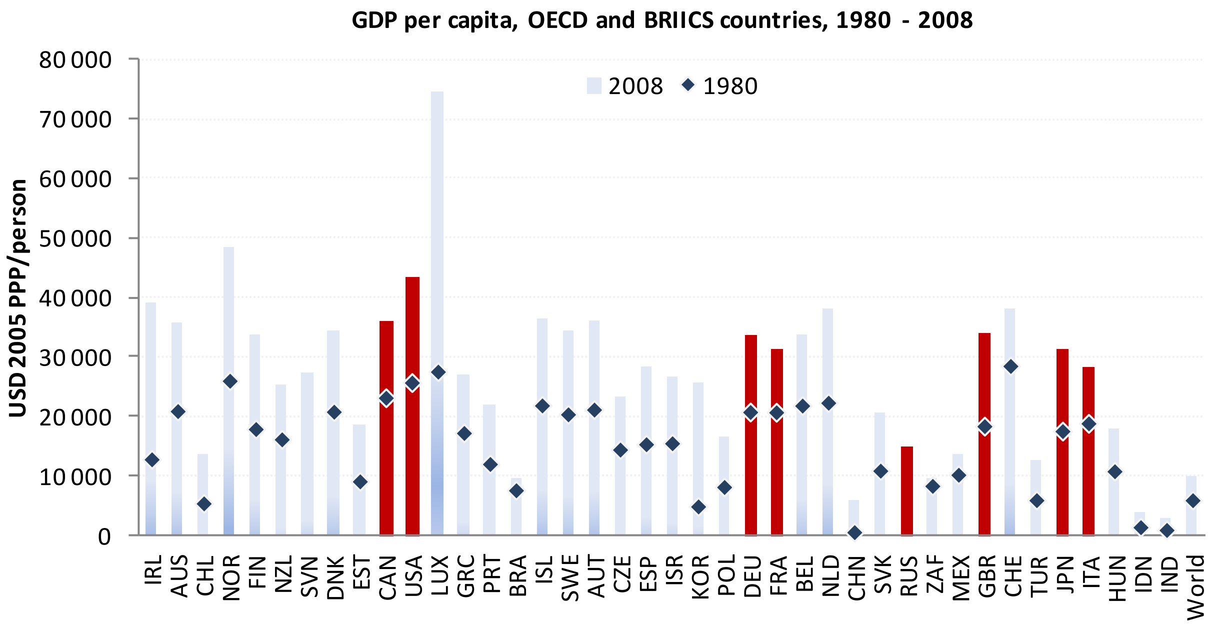


Sources: OECD material flows database and SERI (Sustainable Europe Resource Institute).

TRENDS IN MATERIAL CONSUMPTION



Source: OECD material flows database
Notes: BEL: 1980 data includes Luxembourg; POL: 1980: 1984 data; World: 2008: 2007 data from SERI.



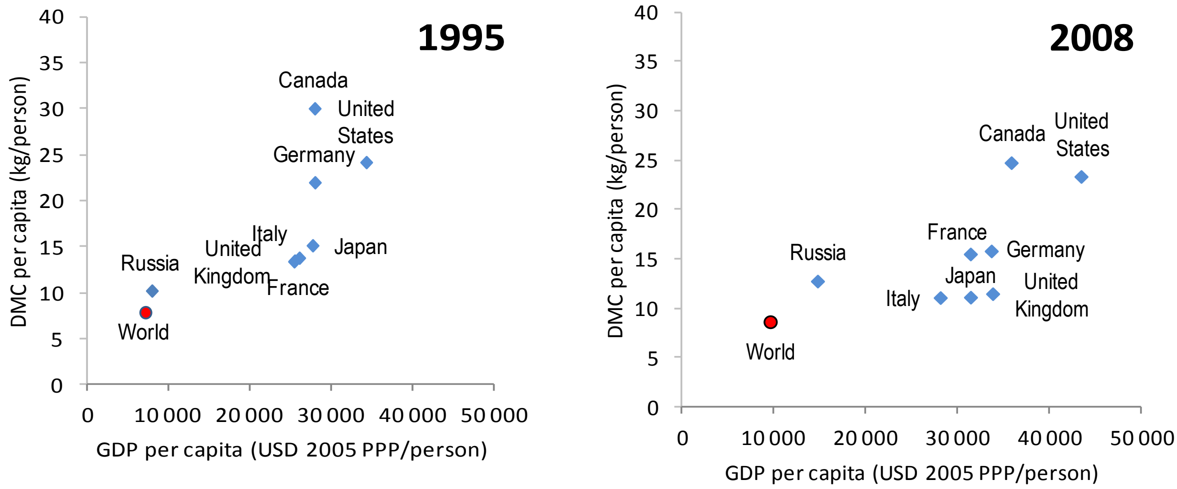
Sources: OECD Economic Outlook, World Bank.
Notes: POL: 1980: 1984 data.

Domestic material consumption (DMC) in G8 countries

	1980	1990	2000	2008	Growth (%) 1980-08	Growth (%) 2000-08
Volume extracted (billion metric tonnes)						
Total	12.1	13.4	14.1	13.0	7.4%	-7.8%
Biomass (food & feed)	2.2	2.2	2.4	2.5	12.3%	4.4%
Wood	0.5	0.8	0.5	0.4	-13.5%	-20.0%
Construction minerals	4.6	5.3	6.0	5.1	10.9%	-15.4%
Industrial minerals	0.5	0.6	0.5	0.4	-29.1%	-20.0%
Metals	0.6	0.7	0.8	0.6	0.7%	-17.9%
Fossil fuels	3.7	3.8	4.0	4.0	8.9%	1.3%
Per capita (metric tonnes/capita)						
Total	19.7	20.6	20.2	17.8	-9.9%	-12.1%
Biomass (food & feed)	3.7	3.5	3.5	3.5	-5.7%	-0.5%
Wood	0.8	1.2	0.7	0.6	-27.4%	-23.7%
Construction minerals	7.4	8.1	8.6	6.9	-6.9%	-19.4%
Industrial minerals	0.9	0.9	0.7	0.5	-40.4%	-23.8%
Metals	1.0	1.1	1.1	0.9	-15.5%	-21.8%
Fossil fuels	6.0	5.8	5.7	5.5	-8.6%	-3.5%
Per unit of GDP (kg/USD at 2005 PPP)						
Total	0.91	0.74	0.60	0.48	-47.0%	-19.8%
Biomass (food & feed)	0.17	0.12	0.10	0.09	-44.6%	-9.3%
Wood	0.04	0.04	0.02	0.02	-57.3%	-30.4%
Construction minerals	0.34	0.29	0.26	0.19	-45.3%	-26.5%
Industrial minerals	0.04	0.03	0.02	0.01	-65.0%	-30.5%
Metals	0.05	0.04	0.03	0.02	-50.3%	-28.7%
Fossil fuels	0.28	0.21	0.17	0.15	-46.2%	-12.0%

Source: OECD material flow database.
Note: Figures do not include Russia.

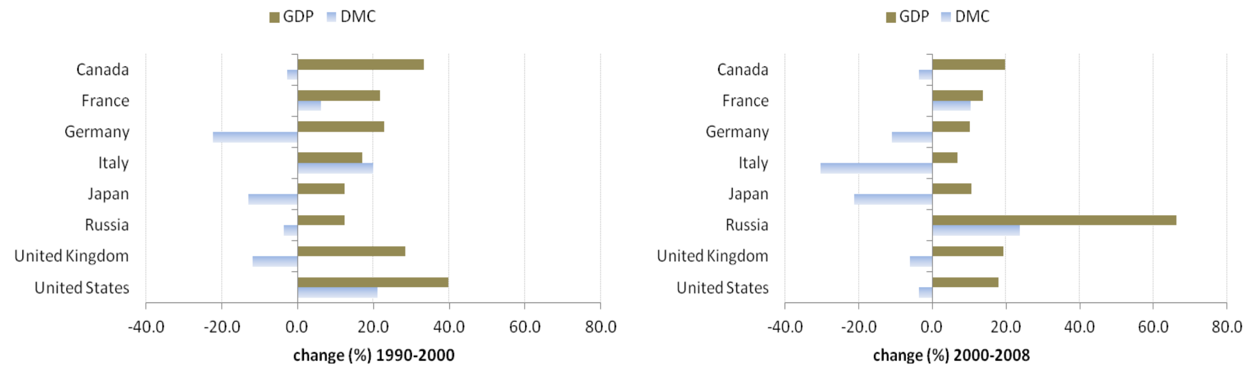
Domestic material consumption (DMC) per capita versus GDP per capita, G8 countries, 1995 and 2008



Source: OECD material flow database and SERI (Sustainable Europe Resources Institute).
Notes: Russia, 1995: 1996 data; World: 2008: 2007 data.

DECOUPLING

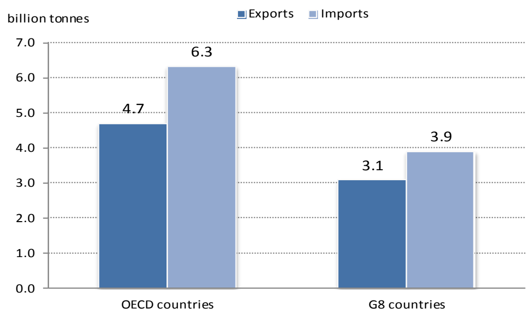
Growth in domestic material consumption (DMC) and GDP, G8 countries 1990-2000 and 2000-2008



Source: OECD material flow database, OECD Economic Outlook and World Bank.
Notes: RUS: figures for 1990-2000 refer to 1996-2000.

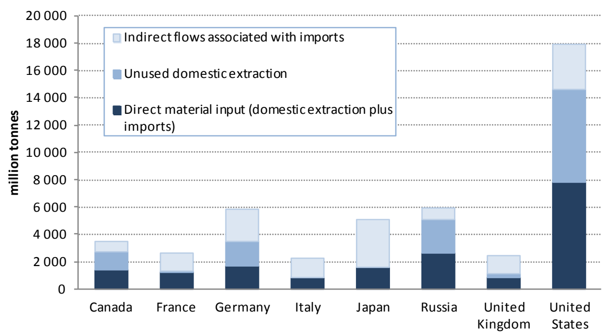
TRADE AND INDIRECT FLOWS

Material imports and exports, OECD and G8 countries, 2008



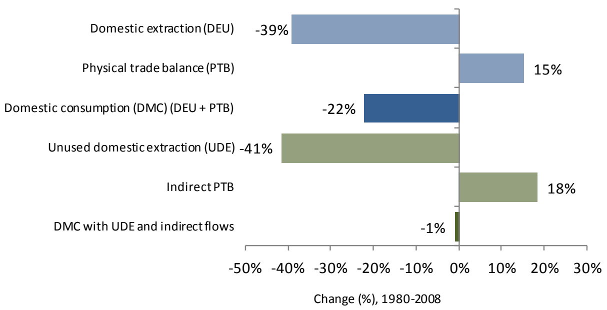
Source: OECD material flows database.
Notes:
G8 figures include Russia. Excluding Russia ,G8 exports are 2.3 Gt and imports are 3.7 Gt, resulting in a direct physcial trade balance of 1.4 Gt net imports.

Direct and indirect material inputs, G8 countries, 2008



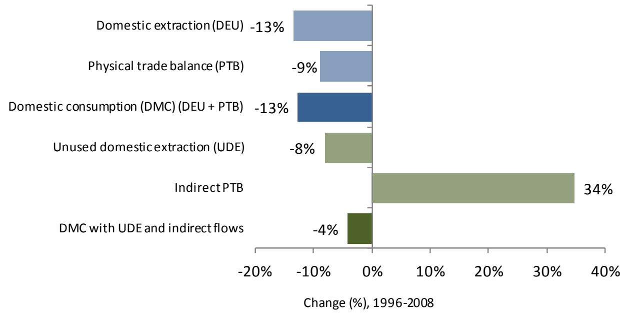
Source: OECD material flows database.

Change in material consumption accounting for unused extraction and indirect flows, Japan, 1980-2008



Source: OECD material flows database.

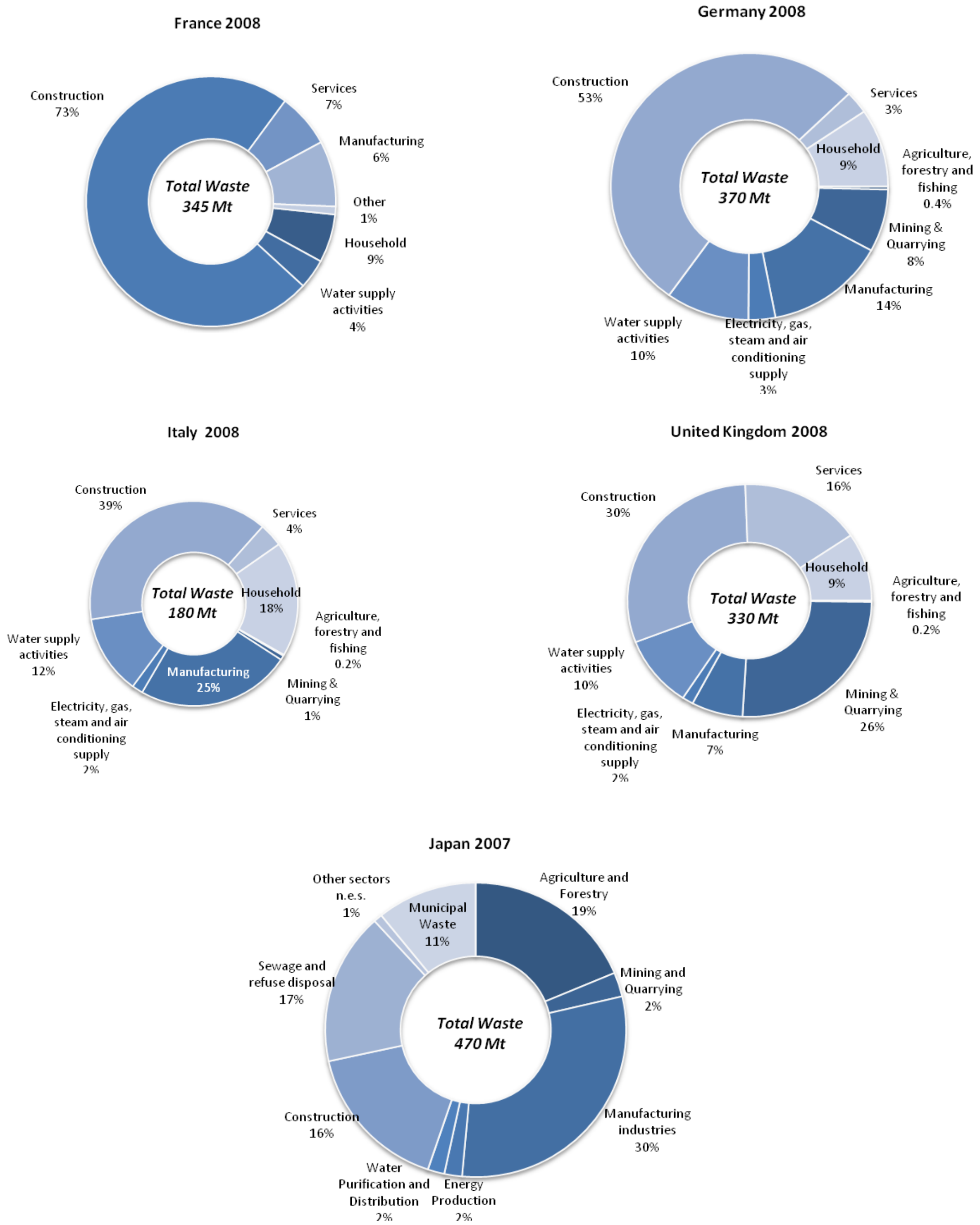
Change in material consumption accounting for unused extraction and indirect flows, Germany, 1996-2008



Source: OECD material flows database.

TOTAL WASTE GENERATION

Total Waste Generation by Source, Selected G8 Economies



Notes and Sources :

FRA, DEU, ITA, UK: Figures from Eurostat. "Water supply activities" include: sewerage, waste management and remediation activities. "Services" includes wholesale of waste and scrap.

FRA : "Other" includes: agriculture, forestry and fishing; mining and quarrying; and electricity, gas, steam and air conditioning supply.

JPN: Figures from OECD.

MUNICIPAL SOLID WASTE

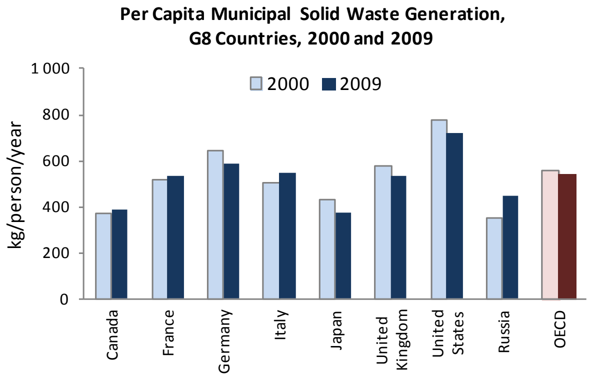
Global Municipal Waste Generation 2009

	Million tonnes/ year	kg/capita	kg/capita/day
OECD Countries	**660**	**540**	**1.5**
G8 Countries	**~500**	**563**	**1.5**
Canada	13	387	1.1
France	35	535	1.5
Germany	48	587	1.6
Italy	33	544	1.5
Japan	48	377	1.0
United Kingdom	33	535	1.5
United States	220	718	2.0
Russian Federation	63	445	1.2
Other BRIICS	**~400**		
Brazil	58	..	
China	157	..	
Indonesia	56	280	0.8
India	108	..	
South Africa	20	420	1.2
World	**1 700 - 1 900**		

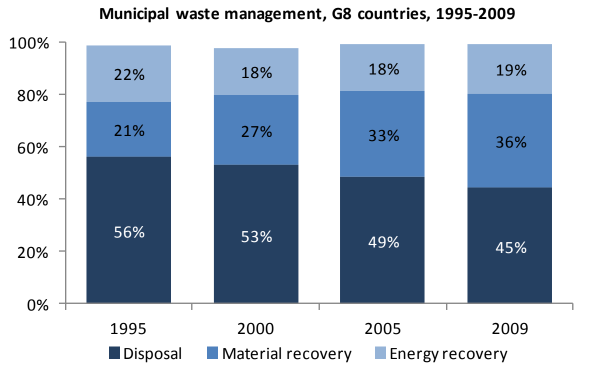
Source: OECD environmental data, UNSD, Chalmin & Gaillochet (2009).

Notes:

Canada: Household waste. 2008 data.
Japan: 2008 data.
Russia: 2007 data.
China: MSW collected.
Indonesia: 1995 data.
India: 2001 data.
South Africa: 2005 data.
World: 2006 data.



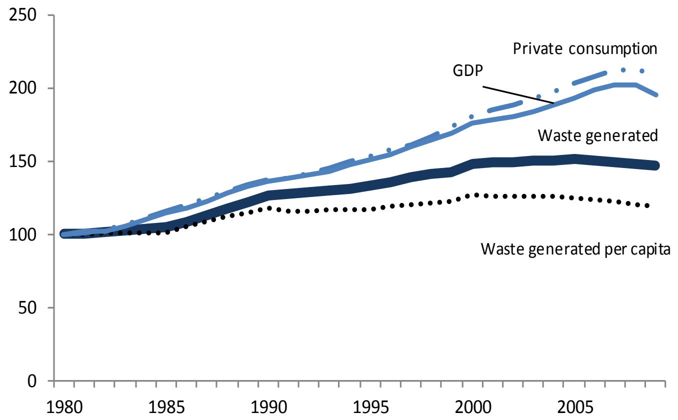
Source: OECD.stat
Notes:
CAN: Household waste, 2009: 2008 data.
JPN: 2009: 2008 data.
RUS: 2009: 2007 data. OECD 2010 Factbook.



Source: OECD
Notes:
Figures do not include Russia.
Disposal includes incineration without energy recovery and landfilling.
Material recovery includes recycling and composting.

DECOUPLING

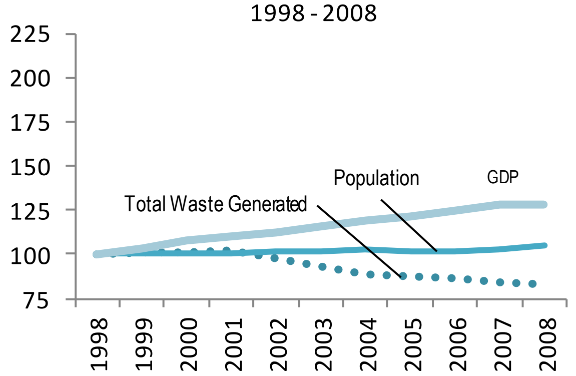
Municipal Solid Waste Generation, G8 countries, 1980-2009 Index 1980=100



Note: Figures do not include Russia.

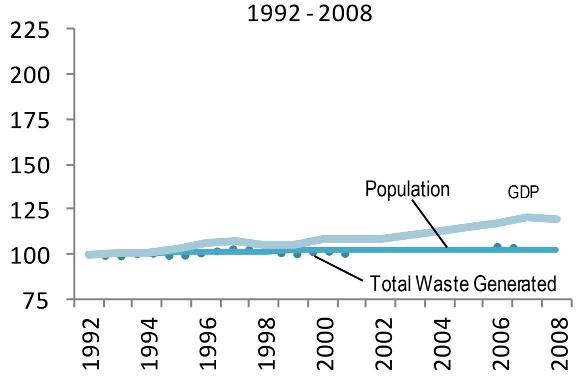
Trends in Total Waste Generated, Selected G8 Countries

United Kingdom
1998 - 2008



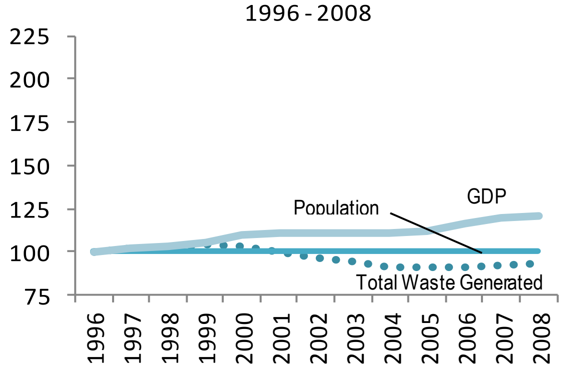
1998=100
Note: 1999, 2000, 2002, 2003, 2005, 2007: estimated values for total waste generated.

Japan
1992 - 2008



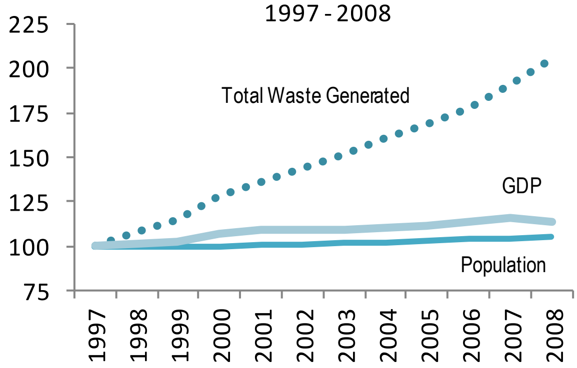
1992=100
Note: Missing values for total waste generated in 2002-2005 and 2008.

Germany
1996 - 2008



1996=100
Note: 2002, 2003, 2005, 2007: estimated values for total waste generated.

Italy
1997 - 2008



1997=100
Notes: 2002, 2003, 2005, 2007: estimated values for total waste generated.
Improvements in the quality of data collection and changes in the definition of waste at the national and European level contributed to the strong upward trend in total waste generation over the time period.

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