Material productivity and waste

Material resources form the physical foundation of the economy. They differ in their physical and chemical characteristics, their abundance and their value to countries. The use of raw materials from natural resources and the related production and consumption processes have environmental, economic and social consequences beyond national borders. Improving resource productivity and ensuring a sustainable management of material resources is critical from both supply security and environmental perspectives.

The main challenge is to ensure that materials are used efficiently at all stages of their life cycle (extraction, transport, manufacturing, consumption, recovery and disposal) and throughout the supply chain. This will avoid waste of resources, reduce the associated negative environmental impacts (both upstream and downstream) and potentially decrease pressures on primary natural resources. Governments have to provide incentives throughout the entire life cycle (including e.g. at product design) to encourage innovation directed at addressing the environmental externalities of resource use. This implies, for example, internalising the cost of waste management into prices of consumer goods and of waste management services. It also demands integration of materials, product and chemicals policies. Countries have used approaches such as circular economy and 3R policies (reduce, reuse and recycle), sustainable materials management and sustainable manufacturing to improve resource productivity.

Detailed internationally comparable data on material flows remain insufficiently available. As a result, this chapter focuses on aggregate measures of material use.

Main trends and recent developments

Global resource extraction is rising, though more slowly in OECD countries

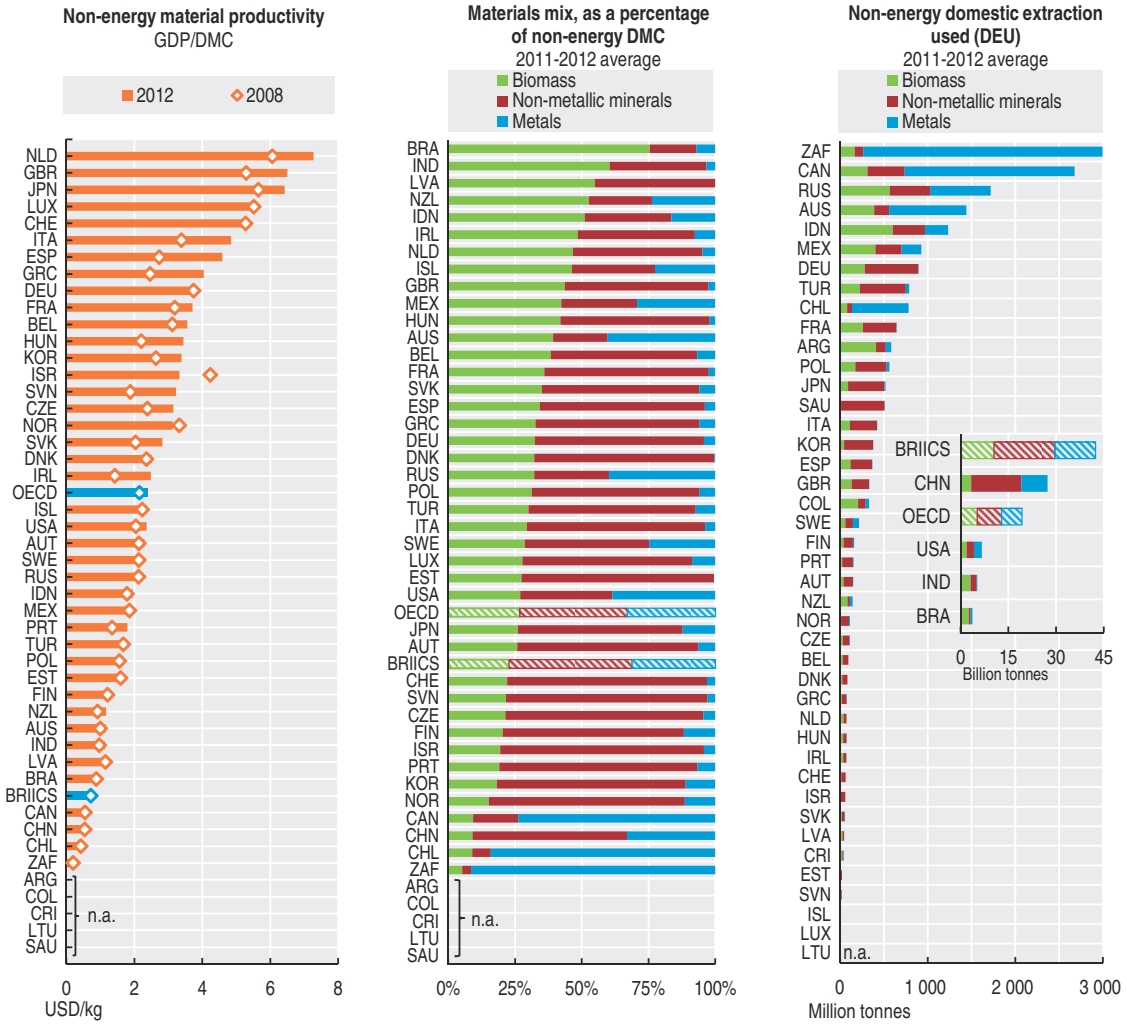
Worldwide use of most significant materials has been rising for many years and has caused concerns over the environmental effectiveness of their use. In some cases, this has been accompanied by supply uncertainty and price volatility.

Among the OECD and G20 countries, the People's Republic of China (hereafter China) and the United States extract most (non-energy) raw materials. They are followed by India and Brazil (mostly biomass), and South Africa and Canada (mostly metals) (Figure 3.1c). At the world level, used material extraction has been steadily increasing since 1980, by over 200%. Much of this increase is due to non-metallic minerals (including construction minerals and industrial minerals), which grew by more than 300% in 1980-2013. This increase represented almost half of materials extracted in 2013 (see *materialflows.net*).

Productivity gains have been achieved, but material consumption remains high

Materials other than energy carriers represent 78% of the materials mix consumption in OECD member countries and 87% in BRIICS economies (Brazil, Russian Federation, India,

Figure 3.1. **Material productivity is growing in some countries but remains low and stagnant in others**



Note: Non-metallic minerals include construction minerals and industrial minerals.
Source: OECD (2016a), "Material resources", *OECD Environment Statistics* (database); Vienna University of Economics and Business (2017) *materialflows.net* online data portal.

StatLink http://dx.doi.org/10.1787/888933484529

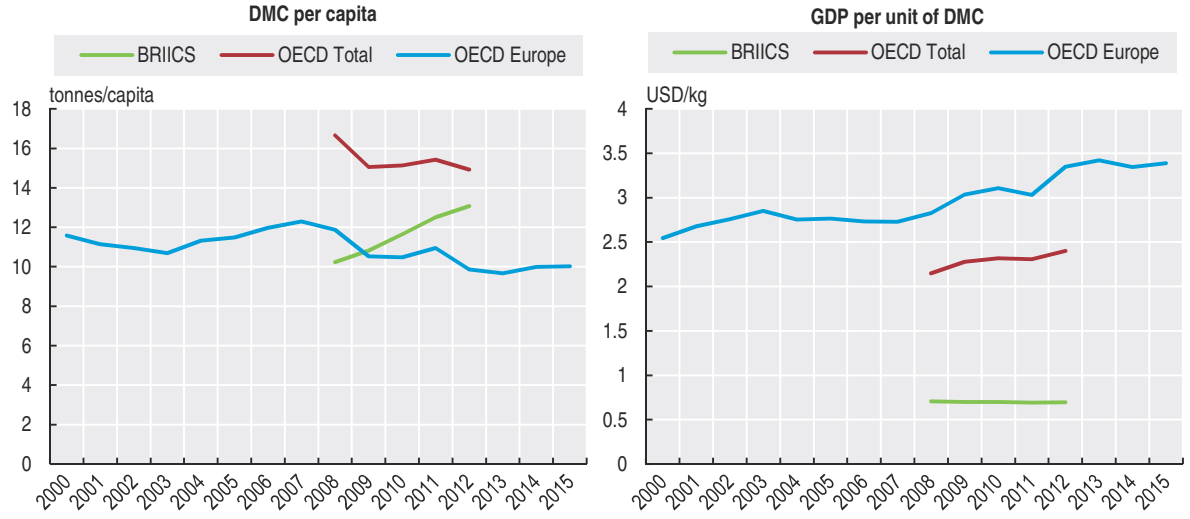
Indonesia, China, South Africa). Material productivity has been improving in some OECD countries (especially in some European countries and Korea). However, it remains low and stagnant in BRIICS economies (Figure 3.1a). In 2012, OECD economies generated about USD 2 400 of income (in terms of GDP) per tonne of non-energy materials used. That is more than three times the value generated by BRIICS economies (USD 700 per tonne, using purchasing power parities [PPPs]).

In many European countries, improvements occurred particularly after 2008. This followed the financial crisis that led to less industrial output and less demand for materials in some sectors, particularly construction.

The consumption of non-energy material resources in OECD countries remains high at about 15 kg per year per capita. It is still about 14% higher than in BRIICS economies although the gap is closing (Figure 3.2). Given their weight, construction minerals dominate the non-

energy materials mix in many countries and determine general trends. This group of materials features low recovery rates and therefore significant potential for efficiency improvements and greater circularity of flows.

Figure 3.2. **Material consumption remains high despite rising productivity**



Note: Aggregates shown here are based on estimates to fill missing values.
Source: OECD (2016a), "Material resources", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933484531

Overall, the general trend in OECD countries is towards lower per capita material consumption and higher material productivity. In BRIICS economies, conversely, the average per capita material consumption is rising fast and productivity gains are very limited.

Progress is moderate once indirect flows associated with trade are considered

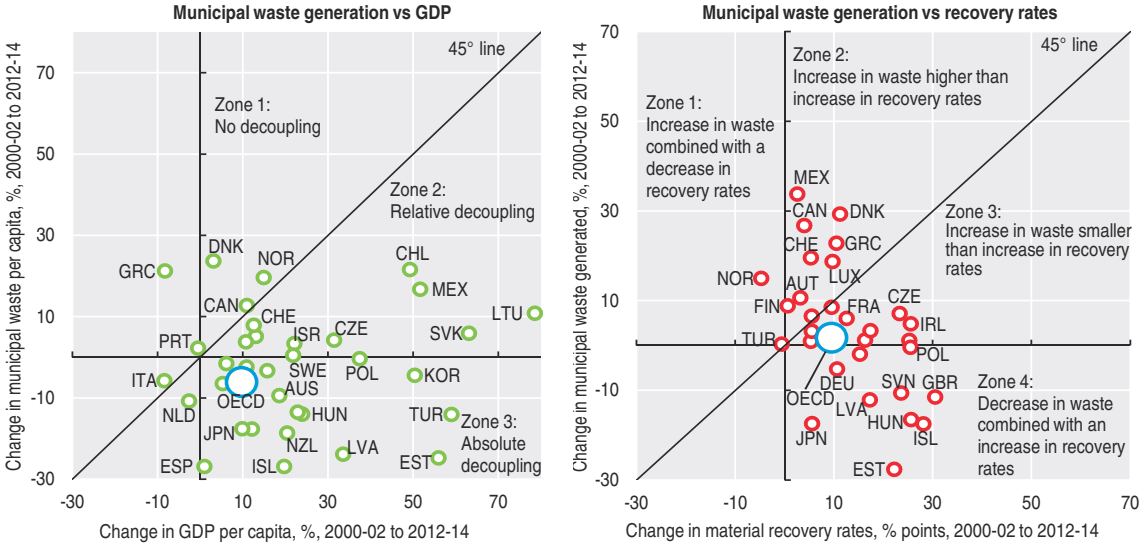
Changing trade patterns and the displacement of resource-intensive production to other countries play a role in productivity gains. According to pilot data, once indirect flows (raw materials embodied in international trade) are considered, improvements in countries that are net importers are often more moderate over longer periods (OECD, 2015; UNEP, 2015). Indirect flows of materials take into account the life-cycle dimension of the supply chain. This includes the upstream natural resource requirements, though the materials are not physically imported. Their environmental consequences occur in the countries where the traded materials originate.

Many materials end up as waste, but efforts to move from waste to resources show results

Over the last two decades, OECD countries have put significant efforts into curbing municipal solid waste generation and encouraging waste prevention in industry. Generation of municipal waste in OECD member countries as a group has increased by 2% since the early 2000s. This shows a modest decoupling from economic growth (gross domestic product [GDP] increased by 12% during the same period) and from population growth (waste per capita fell by 6%). A person living in the OECD generates, on average, 516 kg of municipal waste per year; this is about 40 kg less than in 2000, but still about 10 kg more than in 1990.

In several countries, municipal waste generation intensities decreased by double-digit figures. Most notable were Spain, Iceland and Estonia where per capita amounts fell by over 20% (Figure 3.3a). Seven countries failed to decouple waste generation from economic growth. In Denmark and Norway, per capita waste generation soared in times of moderate economic growth. In some countries such as Portugal waste generation continued to rise despite an economic slowdown.

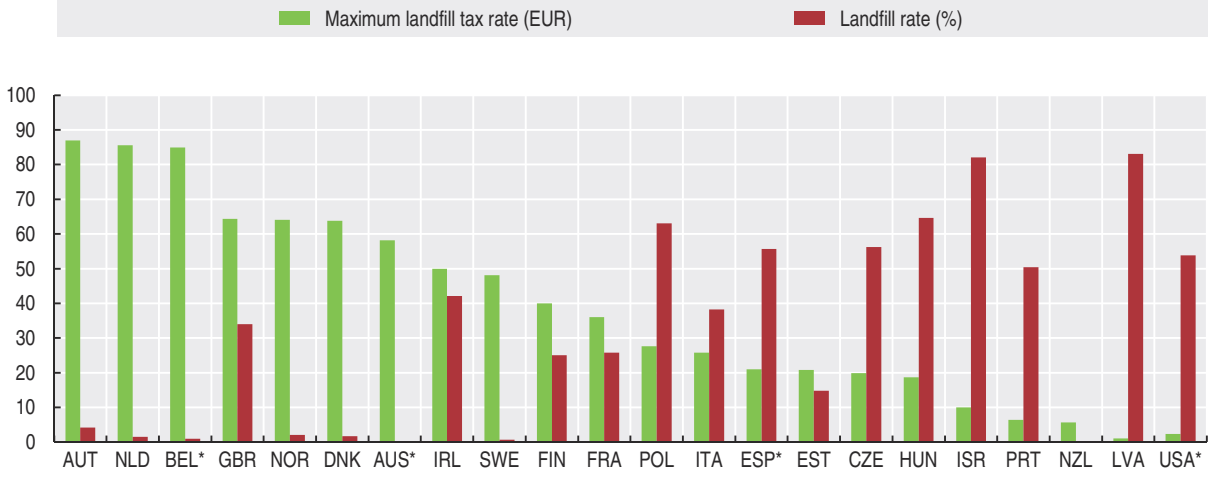
Figure 3.3. **Municipal waste generation has been slowly decoupling from economic growth**



Source: OECD (2016b), "Municipal waste", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933484547

Figure 3.4. **Municipal waste landfilling and tax rates, 2013**



Note: *tax rates refer to Flanders for Belgium, to New South Wales for Australia, to Catalonia for Spain, and to New Jersey, North Carolina, Mississippi and Indiana for the United States.

Source: OECD (2016b), "Municipal waste", *OECD Environment Statistics* (database); OECD (2017a), "Environmental policy instruments", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933484552

Increasing material recovery complements efforts to reduce waste amounts. More and more waste is being diverted from landfills and incinerators and fed back into the economy through recycling and composting. Independent of the progress achieved in reducing municipal waste generation, material recovery rates increased in all countries, except Turkey. The average recovery rate of municipal waste treated in the OECD is now 34%, compared to 25% in 2000.

Significant progress can be observed in many central and eastern European countries where recovery rates were extremely low in the early 2000s. Some countries managed to simultaneously reduce municipal waste generation and increase recovery over the past ten years (e.g. Estonia, Hungary and the United Kingdom) (Figure 3.3b).

Landfilling nonetheless remains the major disposal method in many OECD countries. Landfill taxes are often used to encourage waste prevention and material reuse and recycling. The tax rates usually vary by type of waste disposed (i.e. higher tax rates for recoverable waste). The available data suggest that ten countries levy a maximum tax rate of at least EUR 40 per tonne of waste landfilled. They also indicate a correlation between tax rates and landfilling activity.

Countries with low tax rates, such as the Czech Republic, Israel and the United States, landfill more than half of municipal waste. Other factors that play a role include landfill bans for certain categories of waste (e.g. biodegradable waste), the capacity of recovery and recycling facilities, and the density of population and economic activities (Figure 3.4).

More generally, recycling rates have increased for some high-volume materials, such as glass, steel, aluminium, paper and plastics, but remain low for many others. Many valuable materials continue to be disposed of as waste and, if not recovered, are lost to the economy. Unexploited "urban mines" (e.g. electric and electronic equipment) could be an important source of minerals and metals for the industrial sector. They are also a potentially important domestic source of raw materials in the future. In Europe, about one-third of the 13 400 tonnes of materials consumed every year per person end up in waste. About 17% of this amount is recovered.

Measurability and interpretation

The indicators presented in this chapter relate to the following:

- **Material productivity** defined as the monetary value (in terms of real GDP) generated per unit of materials used (in terms of domestic material consumption, DMC). The focus is on non-energy materials (that is, excluding fossil energy carriers). This indicator is complemented by data on the domestic extraction of materials used in the economy (DEU).
- M**unicipal waste** defined as household and similar waste collected by or on behalf of municipalities, and originating from households, offices and small businesses. **Material recovery** includes recovery for recycling and composting.
- **Landfill rates of municipal waste** defined as the amounts of municipal waste disposed at landfills as a percentage of amounts treated. They are presented with **landfill tax rates**, (i.e. the tax levied per tonne of municipal waste disposed in landfills). Tax rates vary depending on waste types: **maximum tax rates** apply to waste that could be easily recovered (such as recyclable and compostable waste). Final waste is usually subject to a lower rate.

Measures of material productivity extend productivity measurement and analysis to material resources. They complement measures such as labour and capital productivity.

These measures should be read in conjunction with information on commodity prices, flows of secondary raw materials, waste management practices and costs, and consumption levels and patterns. In general, caution is needed when drawing conclusions based on country-level data. Interpretation should take into account the properties and composition of material groups, as well as countries' endowment in natural resources and the structure of their economy. The indicators presented in this chapter do not reflect environmental impacts.

The data on material flows used to calculate the indicators presented here are estimates, and their coverage and completeness vary by variable and by country. Missing information, including on physical flows of international trade, and a lack of consensus on measurement methods, limit the calculation of some material flow indicators at international level. In particular, more needs to be done to monitor flows of secondary raw materials and to calculate internationally harmonised demand-based indicators that measure the raw material equivalents embodied in international trade of goods and services.

Data on the generation and management of waste also remain weak in many countries. The types of waste covered, the definitions and surveying methods employed may vary considerably among countries and over time. See also *Glossary*.

Sources

OECD (2017a), "Environmental policy instruments", *OECD Environment Statistics* (database), *http://dx.doi.org/10.1787/data-00696-en* (accessed in November 2017).

OECD (2017b), "Green growth indicators", *OECD Environment Statistics* (database), *http://dx.doi.org/10.1787/data-00665-en* (accessed in March 2017).

OECD (2016a), "Material resources", *OECD Environment Statistics* (database), *http://dx.doi.org/10.1787/data-00695-en* (accessed in March 2017).

OECD (2016b), "Municipal waste", *OECD Environment Statistics* (database), *http://dx.doi.org/10.1787/data-00601-en* (accessed in November 2016).

OECD (2015), *Material Resources, Productivity and the Environment,* OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264190504-en*.

UNEP (2015), "Material flow dataset", *Global Material Flows and Resource Productivity* (database), *http://undatacatalog.org/dataset/material-flow-dataset-0* (accessed in December 2016).

Vienna University of Economics and Business (2017), *materialflows.net* online data portal, *http://materialflows.net/home* (accessed in March 2017).

Further reading

OECD (2017a), "Guidance on compilation of mineral and energy resource accounts", *OECD Working Papers,* forthcoming.

OECD (2017b), Waste prevention: a survey of policies and programmes across the OECD, Report No. ENV/EPOC/WPRPW(2015)13/FINAL.

OECD (2016a), *Policy Guidance on Resource Efficiency*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264257344-en*.

OECD (2016b), *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264256385-en*.

OECD (2008), Recommendation of the Council on Resource Productivity, adopted by the OECD Council on 28 March 2008, document No. C(2008)40, *www.oecd.org/env/40564462.pdf*.

OECD (n.d.), Resource Productivity and Waste, webpage: *www.oecd.org/env/waste*.

UNEP (n.d.), International Resource Panel, webpage: *www.unep.org/resourcepanel*.