Policy Guidance on Resource Efficiency



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Preface

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. Prosperity and well-being need not be achieved by increasing the "weight of nations" in terms of the resources they consume. The problem is not growth per se, but the composition of that growth. By improving resource efficiency we can decrease the amount of virgin materials that are extracted and used, as well as the associated environmental impacts. 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, G7 Leaders launched an Alliance on Resource Efficiency at their Summit in Schloss Elmau on 7-8 June 2015. This initiative builds on the commitments laid out within the 2008 Kobe 3R Action Plan and broadens them in several ways, including through a stronger involvement of the private sector. In their declaration at Schloss Elmau, G7 Leaders also called upon the UNEP International Resource Panel (IRP) and the OECD to develop a synthesis report and policy guidance on resource efficiency, respectively.

This policy guidance responds to the request by G7 Leaders and complements the report produced by the IRP. It presents the key trends and outlooks related to resource efficiency in the G7 and beyond, and distils policy guidance by focusing around four main areas: the choice and design of policy instruments; how to combine instruments into an effective policy mix; integration of resource efficiency into cross-cutting and sectoral policies; and strengthening of data and analysis to support policy development and evaluation.

Although resource efficiency is first and foremost a matter of national policy decisions, only collective action and coordinated efforts will ensure widespread benefits amongst countries. This report highlights the important role for international co-operation and co-ordination. Moreover, this is an area where G7 can play an important role.

The G7 can underscore the need for resource efficiency policies to address the entire life-cycle of products, as well as the need to align sectoral policies in diverse areas like innovation, investment and trade with resource efficiency objectives. The G7 can also work with other international partners to facilitate integration of resource efficiency considerations in Global Value Chains; address trade and investment obstacles to resource efficiency in supply chains; call for some degree of harmonisation in the field of environmental labelling and information schemes; and help address key information gaps in data for material flows and on economic benefits of resource efficiency policies.

The OECD stands ready to work with the G7 and other international partners to address these important issues and facilitate the transition to a more resource efficient and more circular economy.



Angel Gurría

Secretary General
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Key recommendations

Going for green growth and establishing a resource efficient economy is a major environmental, development and economic challenge today. In this context, improving resource productivity and putting in place policies that implement the principles of reduce, reuse, recycle (the 3Rs) is crucial, as recognised by G7 Leaders in the Schloss Elmau's declaration in June 2015. This report responds to the request by G7 Leaders at the Schloss Elmau Summit asking the OECD to develop policy guidance for resource efficiency. Key findings and recommendations from this report include the following considerations.

Although resource efficiency is first and foremost a matter of national policy decisions, only collective action and co-ordinated efforts will ensure widespread benefits amongst countries. The G7 has an important role to play in this regard.

The G7 can highlight best practices and provide a platform for sharing of experiences both within and beyond its membership. Two key messages from this Guidance are that:

- Resource efficiency policies should target the entire life-cycle of products.
- National policies should put more emphasis on aligning sectoral policies in diverse areas like innovation, investment, trade, education and skills development with resource efficiency objectives.

These broader messages on the life-cycle approach and policy coherence could be explicitly supported by the G7.

The G7 can also strengthen co-ordination and co-operation at the international level by:

- Facilitating integration of resource efficiency considerations in Global Value Chains by supporting businesses in their supply chain management efforts.

- Addressing trade and investment related obstacles to resource efficiency in supply chains, including export restrictions on secondary raw materials, restrictions on trade in used products, and barriers to trade in environmental goods and services.
- Calling for some degree of harmonisation in the growing field of environmental labelling and information schemes, with the aim of maintaining high standards, allowing for increased mutual recognition of schemes, and countering increased costs associated with scheme multiplication across international markets.

Finally, the G7 can help address key information gaps related to material flows and resource efficiency. These gaps include harmonised data on indirect material flows associated with international trade, information on flows of secondary raw materials, disaggregated information on resource use by industry, and information on the quality and deterioration of natural resource stocks. Similarly, the G7 can support internationally co-ordinated efforts to improve economic analysis of resource efficiency, an area that has currently received very little attention in research.

Summary and policy guidance

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 implement the principles of reduce, reuse, recycle (the 3Rs) is crucial. Increased 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.

At their summit in Schloss Elmau, Germany, in June 2015, G7 Leaders agreed that "[b]uilding on the Kobe 3R Action Plan, and on other existing initiatives, we will continue to take ambitious action to improve resource efficiency as part of broader strategies to promote sustainable materials management and material-cycle societies." (G7 Leaders. 2015: 13) In order to allow G7 countries to interact on resource efficiency policy on a common knowledge-sharing platform, the G7 Alliance on Resource Efficiency was founded at the summit, and launched in Berlin in October 2015.

This report responds to the subsequent request by the G7 Leaders at the Schloss Elmau Summit asking the OECD to develop policy guidance for resource efficiency. The report includes a discussion of key trends and outlooks and identifies the main principles that should be used to develop resource efficiency policies.

1. Key trends and outlook

While G7 and other OECD countries have gradually decoupled their use of material resources from economic growth, their per capita material consumption remains significantly above the world average. Decoupling in developed countries has also been insufficient to compensate for increased demand for material resources in the rest of the world

Recent decades have witnessed an unprecedented growth in demand for resources. This has been driven by the rapid industrialisation of emerging economies and continued high levels of material consumption in developed

countries. Since 1990, the global use of material resources has grown slightly slower than – but broadly in line with – global GDP: a trend known as relative decoupling. In the same period, most OECD countries have decreased the use of material resources while their economies grew: this is absolute decoupling. However, the annual per capita material consumption in OECD countries remains high, about 60% above the world average.

There is evidence that policy has contributed to decoupling in developed countries, even though performance among countries varies widely. However, several other factors have also played an important role, though it is difficult to disentangle their contributions from those of policy. Examples of factors that have contributed to decoupling in recent years include: volatile and relatively high resource prices; technological change; the increased share of the less material-intensive service sector in national economies; the substitution of material-intensive domestic production by imported products; and reduced demand for resources due to the global financial crisis.

On current trends of population and economic growth, global material resource consumption is expected to double by 2050, with potentially significant negative impacts on the environment

By 2050, the world population is expected to increase from about 7 to more than 9 billion, and the per capita income of the world's population to roughly triple. This will substantially increase demand for energy, food and natural resources, especially if global production and consumption patterns converge with those in OECD countries. Global material resource consumption is projected to double by 2050. The associated environmental impacts of harvesting resources, using them, and disposing of waste will also increase. Unless environmental management and resource efficiency are significantly improved, natural assets will continue to degrade and become scarcer, with potentially serious adverse economic, social and environmental consequences.

Resource efficiency policies can help to counteract these trends and generate significant positive impacts for the economy and the environment

G7 countries are increasingly committed to developing a circular economy where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised. There is evidence that policies that aim to enhance resource efficiency can deliver multiple benefits, including lower production costs, increased competitiveness, jobs, reduced dependency on commodity imports and fewer adverse effects on the environment. Resource efficiency improvements also support climate mitigation objectives, as well as contributing to the implementation of a number of the recently agreed Sustainable Development Goals.

2. To realise these benefits, resource efficiency policies need to be further developed and mainstreamed

Realising the benefits of resource efficiency requires concerted and coherent policy action by governments in order to respond to the systemic challenge that is posed. This report provides policy guidance that can help governments achieve this goal, organised around four main areas *(i)* the choice and design of policy instruments; *(ii)* how to combine them into an effective policy mix that covers the whole of the product lifecycle; *(iii)* integrating resource efficiency into cross-cutting and sectoral policies; and *(iv)* strengthening of data and analysis to support policy development and evaluation. While the focus is mostly on the measures that governments can take at the domestic level, the report concludes by identifying a number of areas where international co-operation, including in the G7 framework, could make an important contribution in moving this agenda forward.

2.1. Apply mixes of policy instruments so as to provide a coherent set of incentives for resource efficiency along the product value chain

Policy instruments are needed to internalise environmental costs and to provide incentives for efficient resource use. To do this without simply displacing environmental burdens across the lifecycle of products or from one environmental medium to another requires the application of policy mixes that create a coherent set of incentives. The main types of instruments available to policy makers are economic instruments, regulations, information-based approaches, including environmental labelling, voluntary approaches, and public financial support.

Policy instruments have generally been applied further downstream in the product lifecycle rather than upstream. For instance, the number of countries reporting the use of economic instruments such as landfill taxes increased significantly in the past 15 years and this has led to the diversion of waste, away from landfills into material and energy recovery. Efforts upstream of end-of-life management have been more modest: an example is waste prevention, which includes policies that encourage greener product designs and measures to change consumer behaviour.

Policy mixes would benefit from strengthening instruments that target product design and that increase demand for resource-efficient products. Effective policy mixes should be based on a coherent and complementary set of policy instruments, and avoid overlapping or conflicting interventions. Designing policy mixes and selecting individual instruments should be guided by well-established criteria: increasing environmental effectiveness; enhancing economic efficiency; strengthening incentives for innovation; minimising

administrative costs of compliance for business and government; addressing potential impacts on low-income households and vulnerable sectors.

2.2 Implement policies that promote resource efficiency across the lifecycle of products

One of the established principles of resource efficiency is that environmental risks should be managed in an integrated way in order to ensure that the overall use of resources is optimised. OECD countries have been using a number of different approaches to address this challenge, including:

- *Extended Producer Responsibility (EPR)* involves producers taking responsibility for collecting, sorting and treating end-of-life products, following the polluter-pays principle. This approach is now used by a majority of OECD countries for electric and electronic equipment, packaging and tyres. In France, EPR schemes exist for 14 different product groups and Japan has EPR in place for home appliances, packaging and end-of-life vehicles. While these policies have helped to reduce landfilling of waste and increase material recovery, incentives for eco-design can be further strengthened. Further efforts are also needed to ensure that EPR systems operate according to good governance principles, strengthening their transparency with a view to enhancing accountability, improving performance assessment and identifying good practices. The ambition of EPR systems should be increased, better internalising environmental costs, broadening their scope to encompass a larger number of products where possible, and strengthening their enforcement.
- *Green Public Procurement (GPP)* aims to establish resource efficiency criteria for public purchases and can stimulate innovation and increase demand for green products. General government procurement accounts for 12% of gross domestic product and nearly one third of government expenditures in OECD countries. Today, 84% of OECD countries have policies encouraging green procurement at the central government level, such as Japan with its Green Purchasing Act that has been in place since 2000. However, much remains to be done to integrate resource efficiency considerations – including the use of lifecycle analysis – into public procurement programmes. This will require a review of GPP criteria to ensure that they reflect resource efficiency objectives and that they build upon lifecycle analysis. Furthermore, it is crucial that appropriate capacity is built in relevant agencies at national and sub-national level. The OECD Council Recommendation on Public Procurement can serve as an important reference point.

- *Partnerships involving businesses working along value chains.* Several G7 countries have co-operated with businesses working along specific value chains to help develop more innovative approaches to resource efficiency. For instance, the United Kingdom, France and Germany have been actively supporting industrial symbiosis, which engages economic actors in a network to foster eco-innovation and knowledge sharing in order to make one operator's waste another one's material input. Japan is supporting the integration of industrial and urban symbiosis and through its eco-town programme. OECD countries and other adherents to the Guidelines for Multinational Enterprises are also working as a group to promote responsible supply chains and are developing guidance for specific sectors. Given the multiple and diverse challenges along value chains, these partnerships are potentially useful approaches that could be broadened and scaled-up. However, they are a complement to public policy, not an alternative, and their progress should be regularly monitored.

2.3. Treat resource efficiency as an economic policy challenge and integrate it into cross-cutting and sectoral policies

The transition to a circular economy also requires a comprehensive set of policy measures at the macroeconomic and sectoral level. Opportunities should be sought to exploit synergies with other policies, including climate change: there are many win-win opportunities in pursuing low-carbon and resource efficiency objectives, such as in the area of sustainable mobility. At the same time, some of the main barriers to achieving resource efficiency goals are linked to the incentives embedded in policies in other sectors. Analysing the major resource-consuming sectors – agriculture and food, transport, energy – can help to identify policy misalignments with resource efficiency objectives and how they might be overcome. Unless this analysis is performed, resource efficiency policies may be ineffective.

Governments can also support resource-efficient structural change by mainstreaming the pursuit of resource efficiency into cross-cutting policies:

- *Innovation* is an essential means for decoupling resource consumption and growth. Some governments are targeting innovation support on SMEs, often the source of radical innovation. An example is the green action plan for SMEs in Europe, which supports SMEs with information and advice, and facilitates access to finance. A sector-specific example of a pro-innovation initiative comes from Canada: the Canada Mining Innovation Council launched a zero waste initiative which prioritises innovation that is expected to lead to significant reductions in mining waste. Another area where innovation could improve resource efficiency is through the development of new

business models, such as sharing platforms (e.g. cars, accommodation, power tools) or circular supplies. These approaches can be up-scaled and broadened if improving resource efficiency is integrated into national innovation policies, research partnerships are promoted and barriers to the entry of new firms and to the development of new business models are removed.

- *Investment*. The global economy requires around USD 90 trillion of investment in infrastructure between 2015 and 2030. This will translate into significant amounts of resource consumption, creating an important opportunity to ensure that new investment helps to support low carbon and resource efficient development, provided that obstacles to investment in these directions are removed. Public investors should set the example by integrating resource efficiency objectives into standards for buildings and other infrastructure. Private investors should be incentivised to integrate resource efficiency objectives into their investment strategies.
- *Education and vocational training*. The transition to a resource efficient economy will stimulate the emergence of some sectors and the decline of others. While this may or may not lead to a net increase in employment, it will change the skill profile of the workforce. Governments should therefore assess new job skill requirements and adjust education and training programmes accordingly.

These efforts need to be supported by effective governance arrangements at a sufficiently high level of government. This could help to co-ordinate efforts by engaging key stakeholders, to monitor progress, and generally to provide the political impetus needed to achieve ambitious policy objectives. France is attempting to do this through its circular economy roadmap and Finland and the Netherlands have established an overarching mechanism to support coordination and coherence of resource productivity policies.

2.4. Strengthen policy development and evaluation through better data and analysis

Many OECD countries have now established material flow accounts and are developing indicators for resource efficiency. These efforts have been supported by initiatives at the international level, such as the guidance and reference materials for measuring material flows and resource productivity developed by the OECD and the database on international material flows developed by the UNEP International Resource Panel. However, progress has been insufficient when measured against objectives established over the last decade. Adoption of the Sustainable Development Goals (SDGs), which contain a number of objectives and targets related to resource efficiency,

has reinforced the need for strengthened efforts on data collection and the development of indicators, including through enhanced international co-operation in this area.

Better economic data and analysis is also needed to support policy development, and to help make the case for more ambitious resource efficiency policies. Such analysis should focus on the environmental externalities associated with current resource consumption patterns and the economic benefits of addressing them. Appropriate indicators should be developed so that economic policy makers can track the contribution that resources make to economic development.

Many studies have claimed that improving resource efficiency generates macroeconomic benefits such as higher output and more jobs, cost savings for companies, and reduced damage to the environment. Moreover, it is argued that some of these benefits can be achieved at no or low cost to the companies that implement them. There is some evidence to support these claims but this line of research should be deepened. Thus, to ensure that these benefits are realised, the design of resource efficiency policies should be guided by an assessment of their costs and benefits, particularly when establishing objectives and targets.

Finally, policy evaluation should be significantly strengthened: identifying good (and bad) practices and sharing experience can play a key role in designing better policies for resource efficiency and promoting the transition to a circular economy.

3. Strengthen co-operation at the international level, including among the G7

Many of the measures that are required to support the transition towards greater resource efficiency need to be implemented by governments at the domestic level, but as the globalisation of our economies continues and value chains stretch across multiple jurisdictions, there is an increasing need for co-ordinated approaches at the international level. The G7 can play an important role in this respect, including by supporting businesses in their supply chain management efforts, addressing trade and investment related obstacles, using official development assistance to support resource efficiency efforts, and improving environmental labelling and information schemes, as well as resource efficiency data and indicators more broadly.

While it is difficult for national governments to influence the way **supply chains** are managed due to their limited jurisdictional reach, this can be done more effectively at the international level. For instance, within the framework of the OECD Guidelines for Multinational Enterprises, the OECD promotes

responsible supply chains in a number of industrial sectors including the minerals, garment and footwear, as well as agricultural sectors.

Trade and investment is another area of potential focus as international value chains are typically connected through trade and investment in goods and services and restrictions to trade may affect the efficiency with which resources can be used. The OECD and other organisations have identified export restrictions on raw materials as a source of friction and trade disputes among governments and trading partners affected by them. Similarly, restrictions on trade in used products can hamper reuse and remanufacturing activities. Barriers to trade in environmental goods and services such as local-content requirements and trade remedies are limiting the diffusion of the best available environmental technologies and reducing the scope and scale of resource efficiency improvements globally.

Official development assistance provided by the members of the OECD Development Assistance Committee accounted for more than USD 131 billion in 2015, and it is assumed that only a very small share of this currently provides support for resource efficiency improvements. For instance, only about 0.3% is currently related to solid waste management. Significant effects could be achieved if resource efficiency was mainstreamed into development assistance more systematically, leading to more capacity development and technology transfer than is currently the case.

As **environmental labels and information schemes** are increasingly used to encourage consumers to opt for less environmentally harmful products, this is another area where international co-operation could be helpful. There are a number of concerns linked to the proliferation of information schemes, including that this could lead to consumers and procurers finding it harder to distinguish good from bad labels and that firms may bear excess costs in certifying to multiple labels. A range of government and non-government stakeholders have recognised that information schemes multiplication is happening and that there could be benefits to acting at the international level to seek some degree of harmonisation of labels and mutual recognition, reducing their duplication and associated costs across international markets.

Improved **resource efficiency data**, and more robust **economic analysis** of resource efficiency challenges and policies could also be supported by international co-operation. The OECD has identified a number of data-related gaps and many of these require international co-operation to ensure the compatibility of datasets and common definitions and methods. Similarly, there is a need for co-ordinated efforts to improve economic analysis of resource efficiency, an area that has received very little attention in research for the moment and where internationally co-ordinated research efforts could be helpful.

Chapter 1

Introduction

This chapter provides the rationale for developing this report, as well as background on the key initiatives at the international level that are of relevance to the topic of resource efficiency, including the Kobe 3R Action Plan and the internationally agreed Sustainable Development Goals. It also provides some of the key definitions and discusses the scope of this report, which focuses on material resources.

At their summit in Schloss Elmau, Germany, in June 2015, G7 Leaders agreed that "[b]uilding on the Kobe 3R Action Plan, and on other existing initiatives, we will continue to take ambitious action to improve resource efficiency as part of broader strategies to promote sustainable materials management and material-cycle societies" (G7 Leaders, 2015: 13). In order to allow G7 countries to interact on resource efficiency policy on a common knowledge-sharing platform, the G7 Alliance on Resource Efficiency was founded at the summit, and launched in Berlin in October 2015.

To further these engagements, G7 Leaders asked for two reports to be prepared: a synthesis report highlighting the most promising solutions for resource efficiency, and a complementary report that develops policy guidance. The UNEP International Resource Panel (UNEP IRP) was asked to prepare the first, and the OECD the second.

This report is the OECD response to the G7 Leaders' request. It refers to previous initiatives on resource efficiency undertaken by the G7/G8 and related OECD policy work; summarises current trends in resource efficiency and the outlook in G7 countries and beyond; and presents guidance on some of the main policy approaches and instruments that can be employed to achieve greater resource efficiency. The report also refers to resource efficiency initiatives undertaken by G7 countries and the European Commission (e.g. Circular Economy package, A Resource Efficient Europe initiative).

1.1. Resource efficiency initiatives at the international level

In the past, there have been a number of initiatives aimed at promoting resource efficiency, both in the G7/G8 framework and in the OECD. The recently agreed Sustainable Development Goals define a number of objectives that commit the international community to progress in this area.

At the level of the G7/G8, the 2008 Kobe 3R Action Plan synthesised the results of previous G8 work and recommended a set of measures to promote greater resource efficiency through the 3R paradigm: Reduce, Reuse, Recycle (see Box 1.1). These measures covered national actions to achieve resource efficiency, trade in materials and products, and co-operation with developing countries and stakeholders. The Action Plan committed G8 countries to report on measures taken, and requested the OECD to follow up on the progress of work related to resource productivity. Accordingly, the OECD prepared a report in 2011 that reviewed trends and policy developments regarding resource efficiency in the G7 and the OECD more widely (OECD, 2011a).

In the OECD, two successive Council Recommendations on resource productivity were adopted in 2004 and 2008 (OECD, 2004, 2008a), calling on Member countries to "improve information on material flows and to establish

Box 1.1. **Kobe 3R Action Plan**

Goal 1: Prioritise 3Rs Policies and Improve Resource Productivity

Action 1-1: Prioritise Implementation of 3Rs Policy

Action 1-2: Improve Resource Productivity and Set Targets

Action 1-3: Pursue Co-benefits between the 3Rs and Greenhouse Gas Emission Reductions

Action 1-4: Promote Science and Technology and Create a Market for 3Rs-related Products

Goal 2: Establishment of an International Sound Material-Cycle Society

Action 2-1: Collaborate to Promote Sound International Resource Circulation

Action 2-2: Promote International Trade of 3Rs-related Materials, Goods and Products

Goal 3: Collaborate for 3Rs Capacity Development in Developing Countries

Action 3-1: Promote Collaboration with Developing Countries

Action 3-2: Promote Technology Transfer, Information Sharing and Environmental Education

Action 3-3: Promote Partnership between Stakeholders

common measurement systems and indicators", including through improved data collection and methodologies, as well as to "take appropriate actions to improve resource productivity and reduce negative environmental impacts of materials and product use, by encouraging environmentally effective and economically efficient uses of natural resources and materials at the macro, sectoral and micro levels" (OECD, 2008a: 3-5). In 2014, the OECD reviewed the actions taken and the progress achieved in implementing the 2008 Recommendation (OECD, 2014a).

Finally, in September 2015, Heads of State and Government adopted the 2030 Agenda for Sustainable Development. This agenda includes 17 Sustainable Development Goals (SDGs) and 169 targets to be achieved by 2030. Resource efficiency features prominently in the SDGs. As shown in Annex A, 9 of the SDGs and 17 targets refer directly to resource efficiency or sustainable use of resources. In total, 12 of the 17 SDGs depend on the sustainable management of natural resources and the environment (UNEP,

forthcoming). While most of the SDGs and related targets are qualitative, two are quantitative:

- *Target 7.3:* By 2030, double the global rate of improvement in energy efficiency.
- *Target 12.3:* By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

The SDGs are to be implemented by all countries and all stakeholders through collaborative partnerships. A monitoring framework will be established, and progress in achieving the goals will be assessed using a set of global indicators. It is essential to ensure that the G7's resource efficiency initiative and related work within the SDG framework are complementary and supportive (see Box 1.2).

Box 1.2. **G7 country initiatives on resource efficiency**

In parallel with international initiatives, G7 countries have adopted a range of increasingly ambitious resource efficiency policies. Initially this was spurred by the recognition that traditional waste management policies were not adequate to manage the full range of environmental impacts associated with resource usage. Policies were adopted that went beyond an end-of-product-life focus and applied a mix of policy instruments along the entire product lifecycle. The development of such policies called for the engagement of many different sectors and required closer co-operation with industry and other stakeholders.

Snapshots of G7 country initiatives (including the European Union) are provided in Annex B. They show that some countries such as Canada have built on and broadened waste management policies. Japan has spearheaded the 3R – Reduce, Reuse, Recycle – approach. The US has developed a policy that focuses on materials used in the economy with the greatest potential environmental impact. European countries have increasingly linked resource efficiency to structural economic change and the transition to a green or circular economy.

Implementation of resource efficiency policies has resulted in the application of new policy instruments, most notably extended producer responsibility schemes that aim to provide incentives for resource efficiency throughout the product lifecycle. Green public procurement programmes have been established to increase demand for more resource efficient products. Governments have recognised the vital role of innovation and provided various forms of support. Collaborative partnerships between government, industry and other stakeholders have also been central elements of G7 resource efficiency programmes. Different mixes of policy instruments have targeted different stages of the product lifecycle.

Box 1.2. **G7 country initiatives on resource efficiency** *(continued)*

The focus of country programmes varies according to national circumstance. Nevertheless, there are a number of materials and products that feature in several G7 country programmes, including: food waste, plastics, electrical and electronic equipment, metals, critical raw materials, textiles, construction and demolition materials, packaging and end-of-life vehicles. A number of countries prioritise sectors such as the built environment, mobility, energy, mining and forestry.

Despite the different terms used and programmes implemented, G7 countries' resource efficiency policies generally aim to decouple the consumption of resources from economic growth: to do more with less. More specifically, resource efficiency policies, to a greater or lesser extent, aim to achieve the following objectives while meeting people's needs:

- To promote the conservation and sustainable use of natural assets;
- To reduce adverse impacts on the environment;
- To enhance the productivity and competitiveness of the economy;
- To create new economic and employment opportunities;
- To increase the resilience of economies in the face of materials price volatility;
- To address the social concerns arising from an unsustainable use of resources.

See Annex B for a more detailed overview of resource efficiency policies among G7 countries.

1.2. Definitions

OECD work on sustainable materials management (OECD, 2012a) describes how resource efficiency policies employ a variety of closely-related, often overlapping terms; for example, resources, materials, efficiency, productivity, intensity, sustainable materials management, sound material-cycle societies, 3Rs, circular economy, eco-efficiency. These terms, as well as the relative indicators, are sometimes defined differently which risks causing confusion and difficulties when comparing analyses. In addition, there are a wide variety of factors that are not necessarily part of resource efficiency policies but that nevertheless contribute to achieving the related goals (e.g. commodity prices). This makes it difficult to analyse the impacts of specific resource efficiency policies and to capture the full range of actions that influence resource efficiency.

The report prepared by the UNEP IRP (UNEP, forthcoming) presents an extensive analysis of some of these terms. In particular, it distinguishes different ways in which the term "resource efficiency" is used, and provides the following definitions:

- *Resource productivity*: the amount of economic output per unit of resource input. Resource productivity may also be expressed as material or energy productivity. The calculation of resource productivity combines an output expressed in monetary terms and resource input measured in physical terms. It is analogous to the concept of labour productivity.
- *Resource intensity*: the inverse of resource productivity. It measures the amount of resources required to produce a unit of output.

The report also defines two related terms:

- *Technical efficiency*: the ratio of a material output and material input. This is a ratio of two physical parameters.
- *Economic efficiency*: the ratio of the economic values of outputs and inputs. It combines two monetary values and may be applied at both a micro- and macro-economic level. A resource efficient allocation of resources may or may not be economically efficient.

The definitions proposed by the UNEP IRP are consistent with the definitions used by the OECD. The OECD Guide on measuring material flows and resource productivity (OECD, 2008b) specifies:

"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. In this guide, the term *efficiency indicators* is used in a generic way covering both productivity and intensity ratios. One distinguishes:

- *Productivity indicators* that reflect resource or material productivity at national, industry or plant level and that parallel those describing labour or capital productivity.
- *Intensity indicators* that reflect the intensity of use of natural resources or materials at national, industry or plant level. Intensity indicators are the inverse of productivity indicators." (OECD, 2008b: 88)

Given that the mandate from the G7 was expressed in terms of "resource efficiency", this term will be used in this report. However, it should be borne in mind that it may refer to "productivity" or "intensity", though this will generally be clear from the context. In addition, it should be pointed out that the main focus of this report will be on the material aspect of resource

efficiency. Consistent with the definition used in the 2008 OECD Council Recommendation on Resource Productivity (OECD, 2008a) and following OECD work in this area (OECD, 2015a), in this report "the term *resource* is understood to include natural resources (and the materials and products derived therefrom) whose extraction, processing, use and disposal are internationally significant, in both economic and environmental terms." The scope is therefore "limited to minerals (metallic and non-metallic industrial minerals), and biomass. Energy resources (e.g. coal, oil, gas), water resources and fishery resources are excluded and are only covered to the extent that they are part of an integrated approach to the entire resource cycle." (OECD, 2008a: 5)

It is recognised that the nexus between materials and other natural resources such as land, water and biodiversity is becoming increasingly close. One consequence is that pressures on one resource may quickly intensify pressures on others. Thus there is wide recognition of the need to address resources in a comprehensive manner. Indeed, UNEP (forthcoming) adopts such a comprehensive approach.

At the national level, legislation and policies define how terms like "resources" and "materials" are operationalised. As a result, the way G7 countries define "resources" may vary, and may not always be consistent with how such terms are used internationally. For example, Germany's resource efficiency policy uses a narrow definition of resources, essentially abiotic resources; biotic resources are covered by other laws and policies (BMUB, 2012). However, Germany's statistical reporting uses internationally-agreed definitions (Federal Statistical Office of Germany, 2014).

Chapter 2

Trends and outlook

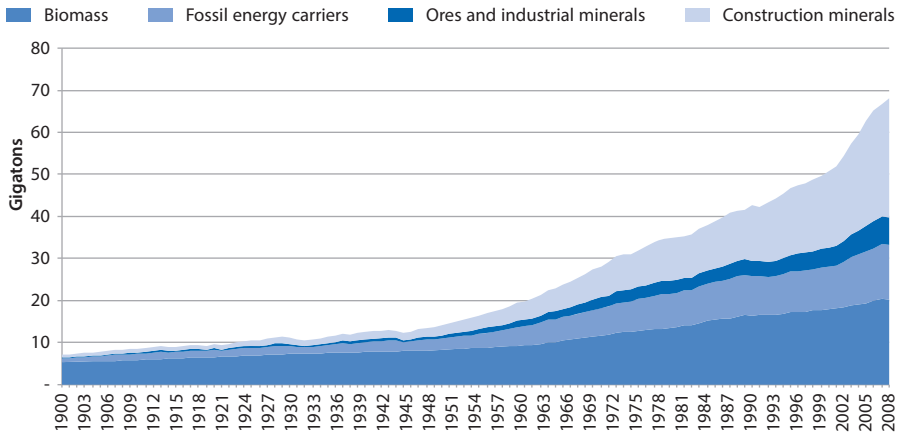
This chapter presents information on current trends, as well as providing an outlook for resource efficiency. It shows that G7 and other OECD countries have made some progress in decoupling the consumption of materials from economic growth. But the global trend is one of continued growth of resource consumption due to an increasing world population and rising living standards. As a result, substantially improved resource efficiency will be needed to meet human, social and economic demands for resources.

This section presents information on current trends using the most recent OECD environmental and green growth indicators. It also examines the outlook for resource efficiency. It shows that G7 and other OECD countries have made progress in decoupling the consumption of materials from economic growth, although per capita materials consumption is still substantially above the world average. An increasing world population and rising living standards will exert significant pressures on the natural resource base. As a result, substantially improved resource efficiency will be needed to meet human, social and economic demands for resources.

2.1. Trends

The last decades have witnessed unprecedented growth in demand for raw materials, driven by the rapid industrialisation of emerging economies and continued high levels of material consumption in developed countries. As a result, the amount of materials consumed worldwide has doubled since 1980, and increased ten-fold since 1900. By 2009, construction minerals accounted for more than 55% of global material extraction; biomass for just over 20%; fossil fuel carriers for a bit less than 20%; and ores and industrial minerals for 5% (Figure 2.1).

Figure 2.1. **Global material extraction 1900-2009**

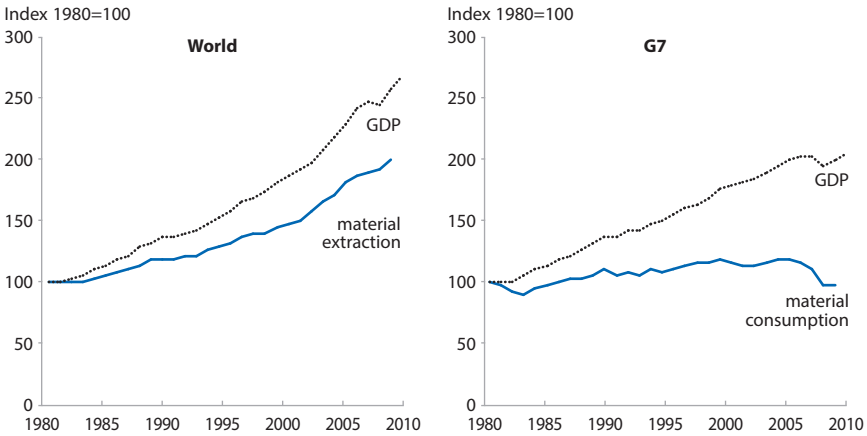


Source: Krausmann et al. (2009).

Since 1990, the global use of material resources has grown slightly slower but broadly in line with global GDP (Figure 2.2). This relative decoupling of material consumption from economic growth has been more pronounced in OECD countries than in the rest of the world. Resource efficiency has

improved such that OECD economies today generate almost 30% more economic value per tonne of raw materials than they did in 2000.

Figure 2.2. **Progress in decoupling materials consumption from economic activity**



Note: Material extraction = Domestic Extraction Used (DEU). Material consumption = Domestic Material Consumption (DMC). DMC equals DEU plus imports minus exports. At the global level DEU and DMC are equivalent.

Source: OECD (2016a), "Material resources", *OECD Environment Statistics* (database).

Prior to the global financial crisis in 2007-08, there were only a few examples of absolute decoupling, with decreasing material consumption and continued growth in GDP per capita, notably in Germany and Japan. Since the crisis, a majority of OECD countries have achieved absolute decoupling, as material consumption across the OECD membership decreased by 11%. Nevertheless, the annual per capita material consumption in OECD countries remains high: at roughly 16.9 tonnes per person per year, it is about 60% above the world average.[1]

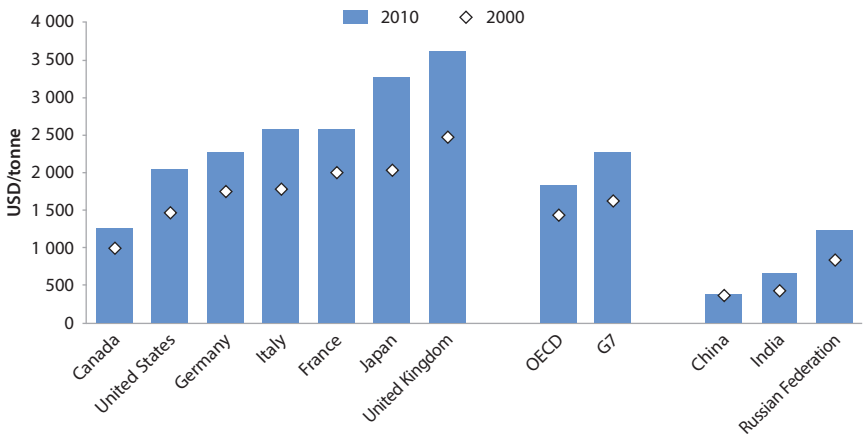
Within these overall trends, the performance of individual countries varies widely. For example, in 2011, the economic value per material unit generated by the United Kingdom is almost three times that of Canada, while in China and India it is about half that of Canada (Figure 2.3).

Several factors have stimulated the improvement in resource efficiency in OECD countries compared with the rest of the world, though it is difficult to disentangle their relative influence.

First, policy action has driven improvements in material efficiency. An increasing number of OECD countries have included resource efficiency as a central objective in their green growth or sustainable development strategies,

often in combination with energy efficiency. Many countries have established plans on sustainable production and consumption, integrated waste and materials management, including the 3Rs or circular economy approaches, stewardship programmes for materials and natural resources, and green public procurement policies.

Figure 2.3. **Material productivity in selected countries**



Note: Domestic material productivity is measured as the ratio of GDP/DMC, where DMC = domestic material consumption.

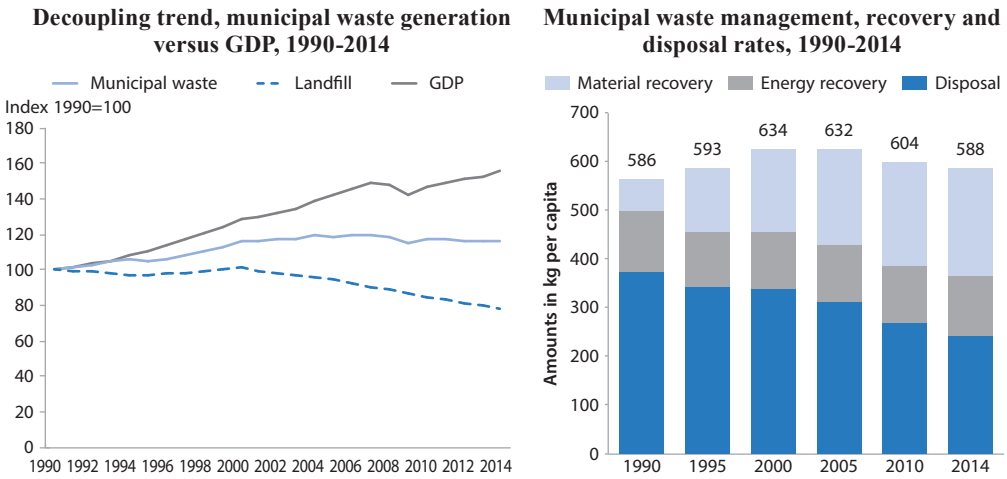
Source: OECD (2016a), "Material resources", *OECD Environment Statistics* (database).

A generally positive trend can be observed for municipal waste: levels of municipal waste disposal have decreased and recycling has increased in OECD countries (Figure 2.4). Since 1990, the amount of waste going to landfill decreased in absolute terms, while the amount of municipal waste generated grew less than GDP. The amount of material recovery in OECD countries increased from 19% in 1995 to 33% in 2010. Energy recovery increased from 17% to 18% in the same period. Recycling rates (i.e. the share of materials recovered from waste) have been increasing for a large range of important materials, such as glass, steel, aluminium, paper and plastics reaching levels as high as 80% for some materials (OECD, 2014a).

Within these overall trends, the amount of recovered waste varied widely among OECD countries (Figure 2.5). A few countries are, or soon will be, recovering virtually all the municipal waste generated either as materials or energy. This suggests that significant further progress in resource efficiency could be achieved if all G7 and OECD countries converged with the front-runners.

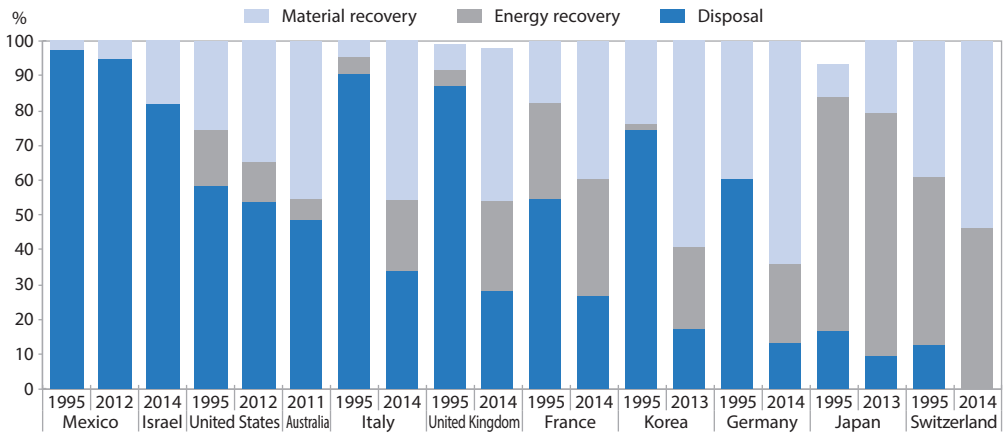
Second, the wider use of more resource-efficient technologies has helped to reduce the amount of materials used per unit of output. Technological change may have been driven both by policies and by commodity prices.

Figure 2.4. **Trends in municipal solid waste in the OECD**



Source: OECD (2016a), "Municipal waste generation and treatment", OECD Environment Statistics (database).

Figure 2.5. **Trends in municipal solid waste management by country**



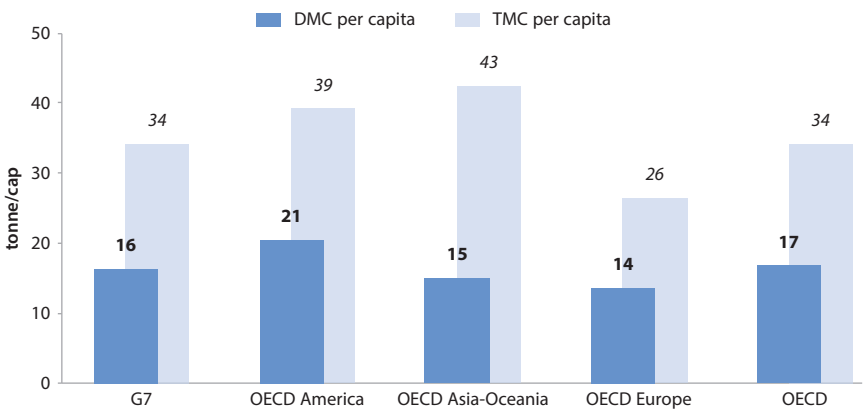
Note: The sum of the categories presented here might not add up to 100% because Other recovery and Other disposal treatments are not presented. Germany and Italy: break in time series.

Source: OECD (2016a), "Municipal waste generation and treatment", OECD Environment Statistics (database).

During most of the 20th century, commodity prices followed a downward trend (UNEP, 2011). However, at the end of the century, demand for resources increased, particularly in emerging economies, and prices became more volatile. High commodity prices created incentives to reduce the consumption of materials, particularly imports that might be subject to supply constraints, and to develop more resource-efficient technologies. It also stimulated exploration and exploitation of resources that had been difficult to access. More recently, prices of commodities have fallen significantly following the global financial crisis and these trends have been reversed.

Third, in most OECD countries structural change has led to a shrinking manufacturing sector and a larger service sector which is less material-intensive. This trend is linked to the outsourcing of resource-intensive domestic production to emerging and developing countries and to the substitution of goods previously produced in OECD countries by imports. When the material consumption associated with these imports is taken into account, OECD countries' progress in resource efficiency and decoupling material consumption from economic growth is less impressive. As Figure 2.6. shows, the consumption-based measure of total weight of materials consumed by G7 countries (TMC), which includes materials embodied in trade as well as unused material such as mining overburden, is about double the production-based measure of material consumption (DMC).[2]

Figure 2.6. **Material consumption per capita: Production- and consumption-based estimates (2010)**



Notes: Tonnes per person per year. TMC = total material consumption. DMC = domestic material consumption. Figures for TMC are partial estimates and do not include excavated soil from construction, dredged sediment or erosion from agricultural land, nor do they include all indirect flows. Actual TMC figures would be higher.

Source: OECD (2016a), "Material resources", OECD Environment Statistics (database).

Fourth, the global financial crisis that began in 2008 significantly reduced demand for materials, particularly for infrastructure and construction. However, data from 2010 shows that material extraction is back to pre-crisis levels (OECD, 2015a).

The trends described above concern materials used in the economy; they do not take account of the pressures that economic activities have placed on renewable resources and of the increasingly close nexus between renewable and non-renewable resources. The pressures on some renewable resources are already considerable (Box 2.1). In the absence of greater resource efficiency they will intensify.

Box 2.1. **Trends in the use of renewable resources**

The most recent OECD data provides the following insights into the use of renewable resources in OECD countries:

Water: The degree of water stress can be assessed on the basis of gross abstractions as a percentage of internal resources. On this measure, 4 OECD countries are high stressed (more than 40%); 4 are medium to high stressed (20-40%); 7 are medium stressed (10-20%). These national level data conceal regional variations in water stress *within* countries.

Biodiversity: In most OECD countries, the number of species identified as endangered is increasing. Specialist birds have decreased by 30% in 40 years. Amphibians are more threatened than birds or mammals. Threats to biodiversity are particularly high in countries with a high population density and high concentration of human activities.

Forests: Forest area has remained stable or even increased in OECD countries while it has decreased at the global level.

Fish stocks: 30% of those assessed are being fished unsustainably; 60% are fully exploited; 10% are under-exploited.

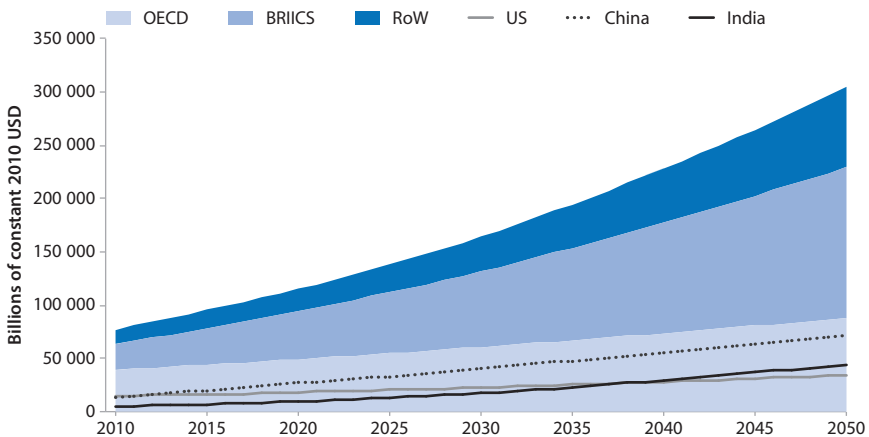
Source: OECD (2015c).

2.2. Outlook

The trends described above show that, at the global level, material consumption has grown slightly slower than, but broadly in line with, economic growth. How will these trends continue in the future? What are the implications for the economy and the environment?

The OECD and the UNEP IRP have examined this issue (OECD, 2012b; UNEP, 2011). Two key drivers of resource consumption will be economic and population growth. The global economy is projected to nearly quadruple by 2050 (Figure 2.7). Within the same timeframe, the world population is expected to increase from about 7 to more than 9 billion and the per capita income of the world's population will roughly triple. As the living standards of a much larger population converge with those of OECD countries, the demand for energy, food and natural resources will increase, as will the associated environmental impacts. Unless environmental management and resource efficiency are substantially improved, the natural capital base for economic activity will continue to degrade, with increasing resource scarcity leading to potentially serious adverse consequences for human health, ecosystems and the economy.

Figure 2.7. **Projections for real gross domestic product to 2050**

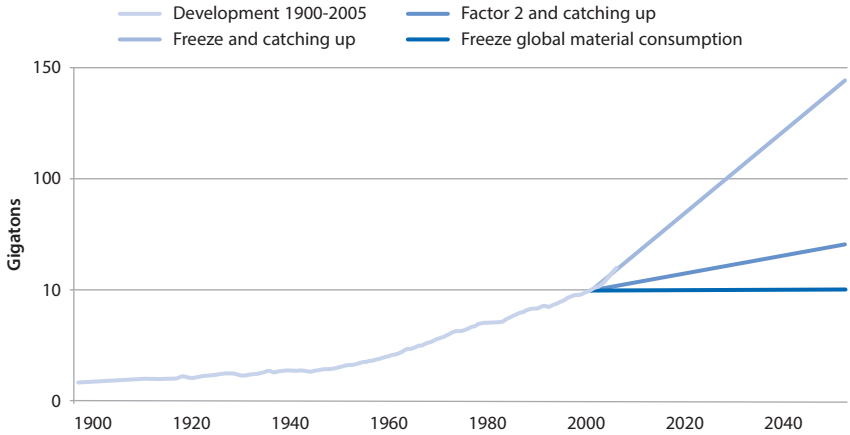


Note: This scenario projection to 2050 is based on the OECD Environmental Outlook Baseline (output from ENV-Linkages). It is valued using constant 2010 purchasing power parity (PPP) exchange rates.

Source: OECD (2012b).

Figure 2.8 presents the three scenarios for resource consumption to 2050 developed by the UNEP IRP (UNEP, 2011). Box 2.2 summarises the main features for each of the 3 scenarios, which could be considered as relatively optimistic. The overall conclusion of UNEP (2011) was that without significant improvements in resource productivity, it will not be possible to meet the needs of a global population of 9 billion people (including the eradication of poverty) by 2050, while protecting the environment and providing for future generations.

Figure 2.8. **UNEP IRP scenarios on global resource consumption to 2050**



Source: UNEP (2011).

Box 2.2. **UNEP IRP scenarios for resource consumption to 2050**

Three scenarios were developed to 2050 with 2000 as the baseline. Key assumptions were that all countries would have a similar resource use per capita by 2050, and that there would be no negative feedback on the economy from resource constraints.

Scenario 1: Business as usual

- Resource consumption per capita in developed countries was assumed to be the same in 2050 as in 2000.
- Global resource use would increase to 140 billion tons per year by 2050.
- Global per capita resource consumption per year would be 16 tons.
- Annual global resource extraction would increase three-fold.

Scenario 2: Moderate contraction and convergence

- Developed countries reduce their resource consumption by half.
- Global resource use would rise to 70 billion tons per year.
- Global per capita resource consumption per year would remain constant at 8 tons.

Box 2.2. **UNEP IRP scenarios for resource consumption to 2050** *(continued)*

Scenario 3: Tough contraction and convergence

- Global resource consumption would be the same in 2050 as in 2000.
- Global resource consumption would be 50 billion tons per year.
- Global per capita resource consumption per year would be 6 tons.
- Absolute resource use in industrialised countries would be reduced by a factor of 3 to 5.

Achieving these targets would require unprecedented levels of innovation and constraints on development that are probably politically unrealistic.

Source: UNEP (2011).

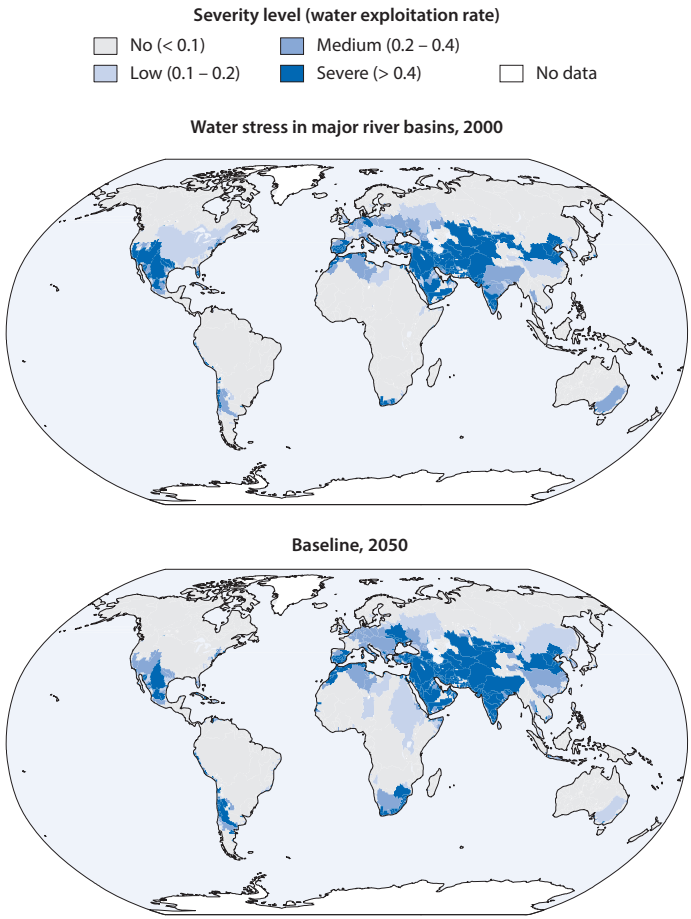
The *OECD Environmental Outlook to 2050* (OECD, 2012b) examined the implications of increased populations and living standards for water resources and biodiversity.[3] Under its Baseline scenario, it projected that if current policies continued and no new policies were introduced, between 2000 and 2050 global water demand would increase by 55%, due to growing demand "from manufacturing (+400%), electricity (+140%) and domestic use (+130%)" (OECD, 2012b: 208). Demands from these uses would put at risk the supply of water to agriculture and ecosystems. Groundwater depletion could become the biggest threat to agriculture and urban water supplies in several regions. As a result, more than 40% of the global population – 2.3 billion more people than today – would be living in river basins under severe water stress. Water stress would be most severe in northern and southern Africa, and central and south Asia (Figure 2.9). Increased water pollution would result in increased eutrophication, biodiversity loss and disease.

In the absence of more ambitious policies, global biodiversity, measured as terrestrial mean species abundance, is projected to "decline by about 10% between 2010 and 2050" (OECD 2012b: 156). Amongst other things, this would have important impacts on rural and indigenous communities whose livelihoods often depend directly on biodiversity and ecosystem services.

Last but not least, the UNEP (2015, forthcoming) and others have shown how the challenges of resource efficiency and climate change are closely related. The extraction, processing and use of resources require much energy, and currently result in large volumes of CO2 emissions. Land use entails emissions of non-CO2 greenhouse gas emissions. The increased material use

linked to the development of many low-carbon technologies will offset some of the decrease in CO2 emissions resulting from the declining use of fossil fuels. Thus global climate policy objectives will not be achieved unless the challenge of resource efficiency is adequately addressed.

Figure 2.9. **Water stress by river basin**



Note: This scenario projection to 2050 is based on the OECD Environmental Outlook Baseline (output from IMAGE).

Source: OECD (2012b).

Notes

1. "The average person living in an OECD country consumed roughly 46 kg of materials per day in 2011, including 10 kg of biomass, 18 kg of construction and industrial minerals, 13 kg of fossil energy carriers, and 5 kg of metals." (OECD 2015a: 78).
2. The OECD and the UNEP International Resource Panel are currently working together to develop an agreed method for estimating total material consumption. See OECD (2015b).
3. The Outlook also examined climate change and human health impacts of air pollution.

Chapter 3

Policy guidance for resource efficiency

The chapter distils policy guidance on resource efficiency in four main areas: choosing and designing policy instruments; combining instruments into an effective policy mix; integrating resource efficiency into cross-cutting and sectoral policies; and strengthening of data and analysis to support policy development and evaluation. The chapter also highlights the important role for international co-operation and co-ordination, and identifies areas where the G7 can play an important role.

The previous chapter has shown how demographic and economic growth are expected to lead to significantly increased demands for material resources and the associated impacts on the environment, as well as point to some of the benefits that improved resource efficiency could help to deliver. This chapter provides guidance on how these trends could be reversed and the benefits realised through concerted and coherent policy action by governments.

3.1 Apply mixes of policy instruments so as to provide a coherent set of incentives for resource efficiency throughout the product lifecycle

A strategic approach to resource efficiency relies on the integration of its principles into economic policy and into product lifecycle management. At the same time, a strategic approach must be underpinned by the application of specific policy instruments at different points in the product lifecycle, from the extraction of materials through to final disposal.

The objective of resource efficiency policy is to internalise environmental costs and to provide incentives for efficient resource use. This requires the application of combinations of policy instruments that create a coherent set of incentives to the various stakeholders involved throughout the entire product lifecycle. There is no "silver bullet" for doing this. Policy mixes must be designed for specific resource, product or waste streams. However, there is an inherent risk in designing such policy mixes: if it is not done in a co-ordinated way, economic distortions may result and environmental burdens shifted from one environmental medium to another, or from one phase of the material lifecycle to the next.

Policy mixes should address each of the main stages of the product lifecycle: material extraction, transport, production, consumption, recycling and final disposal. However, available evidence suggests that current policy mixes are relatively stronger at the downstream end of the product cycle (i.e. at the disposal stage) and could be strengthened upstream (i.e. at the production and consumption stage). A recent OECD report (2015d) suggests that while waste prevention is a potentially effective approach, both in terms of its environmental impacts and in terms of implementation costs, this approach is not being fully exploited (see Box 3.1). The European Environment Agency (2011) considered that its members' measures targeting consumption were relatively weak. The OECD (forthcoming a) concluded that extended producer responsibility systems have had only a limited impact at the design phase. The European Commission's recent Communication (2015) on the circular economy argued that market signals and existing policy initiatives have not provided sufficient incentives for improved eco-design, and that existing requirements have mainly targeted energy efficiency. The Commission indicated that, in the

future, it would systematically examine issues such as reparability, durability, upgradability, recyclability, and the identification of certain materials or substances.

Box 3.1. **Waste prevention in OECD countries**

Waste prevention is regarded as the highest priority and potentially most cost effective approach in the waste management hierarchy. However, a recent OECD study suggests that while many countries have assigned it a higher priority in recent years, much remains to be done to realise its potential.

Twenty-two countries and 2 regions responded to an OECD questionnaire on waste prevention policies and programmes. Eleven respondents (4 non-EU and 7 EU) indicated that they have specific legislation intended to prevent waste generation. Twenty-one countries reported that they had established specific waste prevention programmes. These programmes vary widely in terms of specificity and institutional responsibilities. Interestingly, only five countries indicated a direct link to circular economy or sustainable materials management strategies.

The study examined the measures employed to prevent waste: 179 initiatives were reported covering waste prevention in both production and consumption. Of these, 70% involved information-based instruments, 17% regulated hazardous substances in products and 6% targeted consumption. Economic instruments were mostly used to improve collection and sorting. While this may help to improve material recovery, it has a limited impact on waste prevention.

Fourteen of the respondents indicated that they had established quantitative targets. This provides a basis for monitoring and evaluating progress. However, the use of different targets and indicators limits international comparison. More generally, programme assessment is hampered by difficulties in estimating how much waste has *not* been generated. Similarly, methodological difficulties have limited assessments of environmental effectiveness and economic impacts. Progress in these areas could help to improve the design of waste prevention programmes.

Source: OECD (2015d).

The interactions among instruments in a policy mix require careful consideration (OECD, 2007a). Combining two or more instruments can sometimes enhance the effectiveness and efficiency of both. For example, a well-designed system for separate collection of recyclables together with a variable waste collection charge provides households with an incentive to sort recyclables that can be disposed of for free and thereby also reduce the risk of illegal dumping. Selecting instruments that provide as much flexibility

as possible to the targeted groups increases the possibilities for mutual reinforcement.

At the same time, combinations of instruments that reduce efficiency or effectiveness should be avoided. This is the case with overlapping instruments. When the same actors (i.e. individuals, firms and public administrations) are affected by two instruments that address the same environmental issue, one of the instruments will be redundant. Policy instruments may also work against each other. For example, care should be taken when combining regulations and economic instruments as the former may limit the effect of the latter.

The selection of individual policy instruments should take account of the following criteria:

- Their effectiveness in addressing the identified environmental problem;
- Their ability to achieve the specified objective at least cost;
- The need to minimise the administrative costs of compliance for both government and the regulatees;
- Their impacts on low-income households or vulnerable economic sectors, if any.

Given the importance of innovation in promoting resource efficiency, some consideration should be given to how the policy instruments and mixes might contribute in this regard. The characteristics of policy instruments that one should consider are (OECD, 2011c):

- Stringency – how ambitious is the policy target?
- Predictability – what effect does the policy have on investor uncertainty?
- Flexibility – whether potential innovators are free to identify the best way to meet the objective?
- Incidence – does the policy target the environmental objective as closely as possible?
- Depth – do incentives exist to innovate through a range of potentially ascending objectives?

A striking feature of the literature on resource efficiency is the lack of studies evaluating the impact of policy instruments and approaches on the behaviour of targeted individuals, households and firms, and ultimately on material consumption and extraction. In the case of extended producer responsibility schemes this was found to be largely due to a lack of transparency on the part of producer responsibility organisations (OECD, forthcoming a). There are often also methodological difficulties in distinguishing the role of various policy and non-policy factors in determining resource efficiency

outcomes. Nevertheless, given the diversity of actors involved at various stages of the product lifecycle and the complexity of aligning the incentives of different actors to achieving resource efficiency objectives, it is essential that the impacts of policy instruments and approaches are analysed and lessons learned with a view to improving future policies (Box 3.2).

Box 3.2. **Policy mixes for critical metals in mobile phones**

One of the case studies prepared in the context of OECD work on sustainable materials management considered the range of different policy instruments that could be used at different stages of the lifecycle of critical metals in mobile phones, i.e. beryllium, antimony, platinum and palladium:

- Energy efficiency requirements can reduce energy use and GHG emissions in the processing and recycling of the four metals. Raising awareness and setting standards can help to improve recycling yields and reduce exposure of workers to the health risks associated with the metals.
- Phasing out materials with toxic properties (e.g. beryllium and antimony) from the production of mobile phones reduces human exposure and releases to the environment. Product, materials or eco-design policies could help to improve design for easier recycling and reduced toxicity. These issues could also be addressed in extended producer responsibility schemes or in voluntary agreements between governments and industry.
- The collection of end-of-life mobile devices is a key challenge as collection rates are currently very low. In some countries extended producer responsibility programmes have contributed to rising product capture rates. Given their diminishing life span, a deposit system for these devices or innovative leasing arrangements may also help to raise collection rates.
- Since the technical lifespan of a mobile phone is about ten years, promoting extended mobile phone use through policy ultimately supports sustainable use of materials.

Government procurement contracts could play a role by specifying product durability requirements; alternatively, standard government policy could extend electrical and electronic equipment usage periods.

Source: OECD (2011d).

Table 3.1 illustrates how different types of policy instruments can be applied at different points in the product lifecycle. OECD (2008f, 2011b) provide generic guidance on the selection of policy instruments. The rest of

this section draws on this guidance and examines how it could be applied in the context of resource efficiency.

Table 3.1. **Some examples of policy instruments applied at different stages of the product lifecycle**

	Economic instruments	Regulatory instruments	Environmental labelling and information schemes	Voluntary approaches	Public financial support
Extraction	Taxes on virgin materials.	Bans, restrictions on mining of materials.	Good mining practices.	Agreements on managing environmental impacts of mining.	Tax breaks on exploration, mining.
Design	Advance disposal fees.	LCA-based standards, take-back requirements, standards e.g. for durability.	Environment technology verification schemes.	Research partnerships.	Tax breaks, grants for R&D.
Production	Product taxes or charges.	Emission or performance standards.	Advisory services for SMEs.	Agreements to develop more efficient, less polluting production methods.	Soft loans to SMEs.
Consumption	Deposit refund schemes; pay-as-you-throw pricing for waste collection systems.	Product restrictions or bans.	Labelling andcertification schemes.	Behaviourally-informed interventions (“nudges”).	Grants for the purchase of eco-labelled products or services.
Recycling	Tax differentiation between virgin and recycled materials.	Standards for recycled materials.	Platforms to match supply of and demand for secondary raw materials.	Agreements to create hubs promoting industrial symbiosis.	Tax breaks, grants for research on recycling, industrial symbiosis.
Waste disposal	Landfill and incineration taxes; tradable landfill permits.	Bans, restrictions on landfill.	Information on dismantling products.	Voluntary take-back schemes.	Grants, soft loans to construct waste disposal facilities.

Policy guidance on designing mixes of policy instruments

Apply combinations of policy instruments that: create a coherent set of incentives across the product lifecycle for producers, consumers and other stakeholders; reinforce each other's incentives for efficiency and effectiveness; and avoid unnecessary overlaps or conflicting instruments.

Strengthen instruments that target the design parts of the product lifecycle, that reduce the generation of waste and that increase demand for resource efficient products.

When selecting policy instruments, take account of their: environmental effectiveness; economic efficiency; incentive for innovation; administrative costs of compliance for business and government; impacts on low-income households or competitiveness.

3.1.1. Economic instruments

The use of economic instruments in sustainable materials management policies has been growing steadily since OECD began collecting data in 2000, though this may be partially due to improved reporting (OECD, 2014a). The number of countries reporting the use of landfill taxes increased almost five-fold between 2000 and 2013. Similarly, the level of landfill tax rates increased significantly in many countries over that same period. Similar trends can be observed for the use of incineration taxes, even if such taxes are a more recent phenomenon and far fewer countries apply them. Many communities charge for household waste collection and disposal in a way that provides an incentive to households to reduce the amount of waste for disposal. Taxes on certain products – batteries and packaging for example – are used to reflect the costs of end-of-life disposal, and in some cases deposit-refund systems are used to underpin waste separation and separate collection.

From an economic perspective, economic instruments have several advantages over other policy instruments. The flexibility that they provide allows the regulatee to identify the cheapest compliance option ("static efficiency"). Thus, economic instruments are generally cost-effective. Over time, the flexibility creates incentives to innovate ("dynamic efficiency").

On the other hand, economic instruments are not well suited to dealing with environmental issues such as toxic substances where emissions need to be severely restricted or banned. In some cases, there is political opposition to "another tax". For charges or taxes, it may be difficult to determine how they will influence behaviour and hence the eventual environmental outcome.

Furthermore, taxes or charges may be particularly ineffective in influencing the consumption of goods and services whose demand is price inelastic. Establishing a tax or charge will generally not entail large costs, particularly if it is integrated with other taxes or charges, e.g. taxes on motor vehicles or energy fuels. However, monitoring costs may be high. In contrast, setting up a cap-and-trade scheme (e.g. for tradable landfill permits) can entail substantial costs. If the cost associated with the economic instrument is significant, consideration should be given to its impact on low-income households or firms in trade-sensitive sectors. The adoption of measures to mitigate adverse impacts on these groups may be needed (e.g. revenue recycling). Table 3.2 summarises some of the main advantages and disadvantages of taxes.

Table 3.2. **Taxes: strengths and weaknesses**

	Strengths	Weaknesses	Conditions for favourable use
Taxes or charges on pollution or exploitation of natural resource	• Tend to equalise pollution abatement costs, can raise revenues, continuous incentives to innovate to reduce abatement costs • Implementation can be done through existing national institutions	• Potentially high monitoring costs, uncertainty about level of pollution emissions • Adoption incentives lowered by costs to producers / consumers which are more visible than with permits • Concerns of competitiveness and income distribution • Lower predictability of future policy adjustments	• Public-good market failure is not dominated by monitoring and information costs. • Cross border spill-over effects are important. • Insufficient capacity or scope for a cap and trade system. Baselines can be set and verified at reasonable cost.

Source: OECD (2011b).

No country has established a comprehensive, systematic portfolio of economic instruments (Smith, 2014). Recycling illustrates some of the challenges involved in trying to do so. Recycling can be stimulated by a direct subsidy to recycling activities, or by taxing other disposal options such as direct landfill and incineration. Since the case for promoting recycling is primarily that landfill and incineration have undesirable environmental consequences (external costs such as air pollution and water contamination), taxes on these disposal options can be calibrated more precisely to the scale and pattern of these costs, and will in general lead to superior outcomes to those reached using a recycling subsidy. However, a recycling subsidy might be preferable if high taxes on landfill and incineration would risk stimulating high levels of illegal dumping or unregulated waste burning. The assessment is further complicated when account is taken of the benefits and revenues generated when energy is produced from waste incineration.

In a recent review of economic instruments used in sustainable materials management, Smith (2014) concluded that individual economic instruments have been developed and implemented on a piecemeal basis, without systematic regard to the impact on the overall structure of incentives for producers, consumers and the waste management and recycling industries. The report suggested that there is a need for more clarity and consistency in the definition of the underlying objectives of policy. Relatively few instruments have been set with explicit regard to the external costs of different waste management routes, with the result that incentives are incomplete and do not always encourage the most efficient outcomes from the point of view of the system as a whole. Likewise, policies that promote recycling and materials recovery need to have regard to the value of recovered materials in relation to the costs incurred and to identify more clearly specific reasons that inhibit materials recovery on a commercial basis.

3.1.2. Regulatory instruments

Regulatory instruments include laws or regulations stipulating environmental quality standards (*performance standards*), limits on emissions from various pollutants (*emission caps*), bans on certain products or practices, requirements for the application of certain "best available" technologies (*technology standards*), and obligations for all polluters to obtain environmental permits from pollution control authorities (OECD, 2008f). While these instruments can be applied to a wide range of environmental problems, the main challenge related to their implementation is to avoid undue inflexibilities that may limit their environmental effectiveness and economic efficiency.

In the context of resource efficiency policy, bans and restrictions have been applied to a variety of products and practices ranging from plastic bags to landfilling and mining. Bans allow regulators to reach targeted environmental outcomes with relatively high certainty compared with economic instruments. For this reason, this type of regulatory approach should be preferred in order to restrict highly toxic and damaging emissions. Another situation where emission caps or outright bans outperform economic instruments is where the level of environmental damage rises sharply with the level of emissions from individual sources: strictly capping emissions from individual sources can avoid pollution hot-spots. However, the main downside of bans is that, when a given product or practice is banned from the market, it is not necessarily clear what will replace them.

Environmental standards have been used extensively in sustainable materials management throughout the product lifecycle: standards for recycled materials are a good example of this practice. However, there appears to be opportunities to expand their use in the upstream stages of

the lifecycle, e.g. by establishing stricter requirements at the design phase of products. Their principal advantage is the high degree of certainty they provide about the environmental outcome. In addition, standards are sometimes more politically acceptable than economic instruments, even if in reality there are no significant differences in cost between the options.

There are a number of disadvantages associated with standards. The more prescriptive they are, the more they reduce flexibility and increase compliance costs compared with economic instruments. In addition, they do not provide the same continuous pressure that can stimulate innovation; they do not provide an incentive to go beyond compliance. This disincentive for innovation may be reinforced if incumbent firms are given longer to comply with new regulations than new entrants ("grandfathering"). However, to some extent the disincentives for innovation can be off-set by using performance rather than technology-based standards. Establishing standards can be a resource-intensive task, especially in technically complex areas. Establishing an adequate evidence-base will be difficult when regulatees who hold most of the relevant information, are unwilling to co-operate. As the number of standards increase, so does the enforcement challenge.

Some of the advantages and disadvantages of performance- and technology-based standards are set out in Table 3.3.

Table 3.3. **Standards: Strengths and weaknesses**

	Strengths	Weaknesses	Conditions for favourable use
Performance standards	• Leave flexibility to search for cheapest option to meet standard • High adoption and compliance incentives (relative to pricing instruments) • Certainty over pollution emission levels • Preserve incentives to innovate to reduce costs of meeting standard	• Do not naturally tend towards equalisation of marginal abatement costs • Potentially high administrative costs • Weak adoption incentives in an international context given difficulty in reaching agreement on burden sharing • More information required than for permits and taxes in order to be effective and efficient	• Pollution control at the source of emissions is infeasible or very costly • No adequate proxy for pollutant that could be object of taxation • Weak response of agents to price signals • Pollution emissions can be measured from application of technology

Table 3.3. **Standards: Strengths and weaknesses** *(continued)*

Technology standards	• Low monitoring costs • High adoption and compliance incentives (relative to pricing instruments) • Certainty over pollution emission levels (at individual units level)	• Provides no flexibility to search for cheaper abatement options • Cannot be easily adapted in response to new information about costs and benefits • No incentives to innovate	• Pollution control at the source of emissions is infeasible or very costly No adequate proxy for pollutant that could be the object of taxation • Administrative costs of performance standards are too high • Abatement costs are relatively homogeneous across agents

Source: OECD (2011b).

3.1.3. Information-based approaches including environmental labelling

Environmental labelling and information schemes (ELIS) are useful instruments for improving resource efficiency. They can assist consumers, suppliers and public purchasers to make informed choices, and create demand for sustainable goods and services. Their effects increase in proportion to the private benefits involved, and to the extent that the information enables a choice to be made among a range of alternatives (e.g. a selection of goods with differing energy efficiencies). From a resource efficiency perspective, ELIS are most relevant when they are based on a lifecycle assessment of the product.

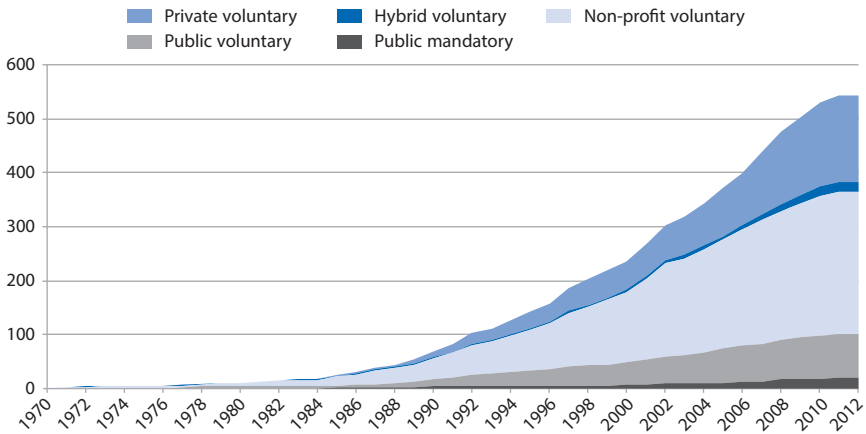
Information-based approaches may also play a useful role in policy mixes. For instance, combining labelling schemes with taxes on energy use can reinforce incentives to choose more energy efficient appliances.

In recent years, insights from behavioural economics and behavioural sciences have helped to strengthen information-based approaches. For example, there is evidence that providing consumers with information on how their consumption of energy or water compares with their neighbours' can "nudge" some consumers to reduce their consumption (see Allcott, 2011). This shows that leveraging on behavioural insights can make information provision more effective by taking into consideration cognitive biases

Gruère (2013) identified 544 environmental labelling and information schemes that were in operation in 2012 covering 197 countries. These schemes were fairly evenly distributed over several environmentally relevant policy areas: energy and climate change (24%), chemicals control (21%), natural resources (20%), waste (14%), biodiversity (11%), other (10%).

Gruère (2013) shows how these schemes have expanded significantly in recent years (Figure 3.1): non-profit voluntary schemes largely dominate over time, but the number of private schemes has also increased rapidly, faster than the number of public voluntary schemes. Other categories are substantially smaller. Gruère (2013) found that a high proportion of ELIS did not use lifecycle approaches, though many do use standards focusing on the impacts of the production phase of goods (non-product-related processes and production methods). A majority of the schemes operate at the national level. A growing share use third-party auditing or verification. However, most of these schemes remain non-transparent in their standard-setting process, even though there is a limited but relatively faster increase in transparent schemes. Recent years have seen growth in quantitative "footprint" type labels, though companies have used different and inconsistent methods to assess the environmental footprint of their products.

Figure 3.1. **Evolution of the number of ELIS by modes of governance and ownership (1970-2012)**



Source: Gruère (2013).

While some of the long-established government-backed schemes have retained their authority and serve as useful guides, the multiplication of environmental labelling and information schemes has generated confusion and concern about misleading labels and claims (Prag et al., 2016). Governments could help address concerns, for example, by endorsing high-quality schemes (including through public procurement), enforcing existing rules more vigorously, including on unfair commercial practices related to misleading claims, and facilitating agreement on methodologies for assessing

the environment footprint of products (European Commission, 2015). Governments should also ensure that information schemes do not create unneccessary obstacles to international trade.

3.1.4. Voluntary approaches

Governments have co-operated with different business sectors to overcome some of the difficult obstacles to resource efficiency that are not readily amenable to traditional policy instruments or market forces. Some of the factors that can make such approaches successful will be further discussed in section 3.2.3. Voluntary approaches can also be readily integrated into a mix of policies addressing a particular part of a product lifecycle (Box 3.3).

Box 3.3. **Collection of mercury switches in the US**

The US Environmental Protection Agency (US EPA) promoted a voluntary initiative to remove mercury-containing switches from scrap automobiles prior to recycling. Nearly all obsolete automobiles in the US are dismantled, shredded and burnt in furnaces to recycle the metal, thereby releasing mercury emissions to the air. The US Clean Air Act gives the US EPA authority to regulate steel mills, but not car dismantlers. There was little that steel producers could do other than install expensive end-of-pipe equipment to remove mercury from emissions. The car dismantlers had little incentive to remove mercury-containing switches due to the low value of the mercury involved and the additional costs of the procedure. The 2006 US National Vehicle Mercury Switch Removal Program was a voluntary initiative involving automobile and steel manufacturers, scrap recyclers, vehicle dismantlers, environmental groups and the States. It aimed to facilitate the removal of mercury-containing switches before recycling, including through a fund established to compensate car dismantlers. The programme is still operating although the resources of the fund were depleted in 2009.

Source: OECD (2008f), US Environmental Protection Agency (2016).

In some cases, voluntary approaches are an alternative to regulation, providing one or more sectors with the flexibility to find an innovative, less costly means to achieve an objective. There will also be lower costs for government who retain the option of regulating if the initiative does not succeed. The outcome of such approaches depends largely on the benefits to participants of collaborating, including by avoiding regulation, and the absence of obstacles to co-operation (such as not having to share confidential information).

3.1.5. Public financial support

Public expenditures can help to achieve resource efficiency policy objectives in a variety of ways, including by providing support to R&D, and for investments in waste management infrastructure and other resource efficiency projects. However, governments are rightly cautious about using public financial support. The polluter-pays principle is basically a no-subsidy principle that asserts that governments should not provide public financial support to enable industry to comply with environmental requirements. However, targeted and time-bound public financial support may be justified in specific situations characterised by market failures or a need to secure public goods that justify public expenditures.

In all instances, the use of public financial support instruments should be restricted to cases where they provide the most efficient, or only, means of achieving a policy objective. They should be used in a targeted manner, in association with clear objectives and within a defined timeframe: once the objectives have been achieved, the support programme should be terminated, in order to avoid perpetuating public expenditures beyond what is needed (OECD, 2008f).

However, public financial support also involves complications around targeting and raising and allocating limited public funds. These instruments place complex information requirements on governments in the design phase, and need substantial administrative capacity in the management phase.

In the limited and aforementioned situations when targeted, time-bound public finance is justified, OECD (2006) presents general principles and a series of checklists to assist governments in designing programmes that are environmentally effective and consistent with good practices of public finance. The key steps recommended are:

- "Define priority environmental objectives using evaluation methods, such as risk assessment, cost-benefit analysis and cost-effectiveness analysis, as well as participatory political processes.
- Demonstrate that public expenditures are necessary to achieve these objectives.
- Define the sources of funds, the size of the budget, and the terms and conditions of the expenditure programme.
- Authorise an appropriate institution to manage the expenditure programme.
- Continue, modify or terminate the expenditure programme in light of periodic reviews of the programme's performance to assess whether its objectives have been achieved and its continuation is necessary." (OECD, 2006: 5)

A variety of public financial support instruments are available to governments (OECD, 2006). Grants are the most administratively simple and transparent. When used, they should maximise incentives for timely and cost-effective project implementation, maximise the leverage of other financial resources and minimise chances of misuse of public money by beneficiaries.

Other public financial support tools may be considered in proportion to the institutional capacity to manage the associated risks. In order of increasing risk, these tools include: interest subsidies, loans through intermediaries, direct loans, leasing, equity investments and loan guarantees.

Governments may also use the fiscal system to provide incentives for investments by the private sector. For example, tax breaks have been used to support R&D, and accelerated depreciation to encourage specified investments. However, unless these instruments are well-targeted – the administrative resources required will generally increase in proportion to the extent of targeting – there is a risk that the foregone tax revenues will benefit investments that would have been made anyway, and that they will favour incumbent firms that may be less likely to innovate than new market entrants.

Private companies should generally finance investments in resource efficiency from their own funds or by accessing capital and financial markets. However, some firms, especially SMEs, may have difficulties accessing finance. As a result, governments have established financing mechanisms and advisory services to address these market failures (Box 3.4). The provision of finance through such mechanisms should generally be on commercial terms. The provision of any concessional finance should be justified in relation to specific market failures.

Box 3.4. **Financing the circular economy in Europe: Co-operation between the European Commission and the European Investment Bank**

The European Investment Bank (EIB) traditionally finances large, commercially viable projects directly with medium and long-term loans with fixed or variable interest rates. For smaller projects in SMEs, the EIB provides finance indirectly through credit lines that it establishes in local banks and other financial intermediaries. The EIB and the European Commission also co-operate in some cases by blending EU grants with EIB loans. This approach enables loans for some types of projects to be offered on concessional terms (e.g. lower interest rate and/or pay-back period).

Box 3.4. **Financing the circular economy in Europe: Co-operation between the European Commission and the European Investment Bank** *(continued)*

The transition to a circular economy has involved a broadening of EIB's investment focus from traditional municipal waste infrastructure to include commercial and industrial waste streams, in particular for recycling and waste recovery. Often, such projects involve more risk than projects normally supported by the EIB. To address this challenge, the European Commission and the EIB have established a new mechanism. The European Fund for Strategic Investments (EFSI) consists of a EUR 16 bn guarantee from the EU budget and EUR 5 bn of the EIB's own capital. It can provide guarantees and other forms of support for projects in strategic sectors, including the circular economy, that have a higher risk profile.

The European Investment Advisory Hub (EIAB) has been established to provide a single point of entry for advisory services for investment projects in the EU. Advice is provided by specialists, including in-house EIB staff, in strategic areas, including those related to the circular economy. Services available include project development support throughout all stages of the project cycle, as well as upstream or policy advice on market studies, sector strategies, and project screening.

Source: European Investment Bank (2015).

Policy guidance on individual policy instruments

Ensure that existing and new economic instruments provide a coherent set of incentives in line with the policy objectives they are intended to achieve.

Consider how standards could reinforce incentives for resource efficiency at different parts of the product cycle, e.g. design, while providing flexibility to identify cost-effective means of compliance.

Give recognition to environmental labelling and information schemes (ELIS) that are based on robust, independent analysis, including lifecycle analysis; hold proponents of these schemes accountable for their environmental claims; work with business to develop credible, consistent methodologies for assessing the environmental footprint of products across their lifecycle; ensure that domestic schemes do not discriminate against foreign products.

In keeping with the polluter-pays principle, only use financial instruments when they are the most efficient, or only, way to redress market failures or to provide public goods related to resource efficiency; ensure that adequate institutional capacity exists to manage any risks associated with financial instrument used.

3.2. Implement policies that promote resource efficiency across the lifecycle of products

One of the established principles of resource efficiency is that environmental risks should be managed in an integrated way to avoid problems being displaced along product lifecycles or to other environmental media. This section examines three approaches that, building upon different policy mixes, have sought to address resource efficiency along product lifecycles: extended producer responsibility; green public procurement; and partnerships involving businesses working along value chains.

3.2.1. Extended producer responsibility

Extended producer responsibility (EPR) was one of the first attempts to manage the environmental impacts of products throughout their lifecycle. In 2001, the OECD prepared a guidance manual in which it defined EPR as an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's lifecycle (OECD, 2001).

In practice, EPR involves producers taking responsibility for collecting end-of-life products, and for sorting them before their final treatment, ideally, recycling. EPR schemes can allow producers to exercise their responsibility either by providing the financial resources required and/or by taking over the operational and organisational aspects of the process from municipalities. They can do so individually or collectively through producer responsibility organisations.

A recent OECD study (OECD, forthcoming a) took stock of progress with EPR and provided updated guidance. About 400 EPR systems are currently in operation, nearly three-quarters established since 2001. Legislation has been a major driver, and most EPRs appear to be mandatory rather than voluntary. Small consumer electronic equipment accounts for more than one-third of EPR systems, followed by packaging and tyres (each 17%), end-of-life vehicles, lead-acid batteries and a range of other products. Various forms of take-back requirements are the most commonly used instrument, accounting for nearly three-quarters of those surveyed. Advance disposal fees (ADF) and deposit-refund systems account for most of the rest.

Assessing the impacts of EPR systems is difficult for several reasons: a serious lack of data; analytical difficulties in distinguishing the impact of EPR systems from other factors; and the wide variety of EPR systems which limits comparison among them. Nevertheless, there is evidence that in some countries (e.g. France), EPRs have helped to shift some of the financial burden for waste management from municipalities and taxpayers to

producers, and to reduce the public costs of waste management. It also seems likely that EPR systems have contributed to the decreased share of waste destined for final disposal and to the increased rates of recycling recorded in many OECD countries. However, progress in these areas varies very widely among countries, suggesting that there is scope in many countries to improve their performance by emulating the best performers.

A key message in the 2001 guidance manual was that there is no single "right approach" when designing EPR systems. Solutions need to be tailored to achieve defined objectives in specific economic, political and cultural contexts. Accordingly, it was recommended that EPRs be established in accordance with general good governance principles such as setting clear objectives, operating transparently, monitoring performance and so on. OECD (forthcoming a) found that the quality of governance in many EPR systems could be significantly improved. In particular, there was a lack of transparency that made it difficult to assess performance, identify good practices and adjust EPR systems to make them more efficient and effective.

OECD (forthcoming a) also found that many of the recommendations from the 2001 OECD guidance manual were still relevant and should be applied more systematically. In addition, there are opportunities to make EPRs more effective including by increasing their level of ambition; broadening the scope of products covered; better internalising environmental costs; and strengthening enforcement, particularly to reduce free-riding and leakage.

A key objective motivating the establishment of EPR was that it would promote more resource-efficient eco-design: it was thought that making producers responsible for their products in the post-consumer phase would create incentives to design their products in a way that reduced environmental impacts throughout the product lifecycle, including at the end of the product life. However, the consensus appears to be that while EPR systems have contributed to eco-design in some countries and some sectors, they have seldom been sufficient to serve as the triggering factor. The impacts of EPR systems seem to have been mainly downstream rather than upstream. The EPR for household appliances in Japan appears to be a notable exception in this respect (Box 3.5). Several approaches were identified that could stimulate better eco-design including: ensuring that producers bear the full end-of-life costs of their products (which may vary among producers), linking EPRs with broader innovation initiatives and, in the case of globally traded products, by harmonising environmentally sensitive design features.

Many EPR systems are managed by producer responsibility organisations (PROs). In most cases, they were originally established as monopolies, raising concerns that PROs would exploit their monopoly power by charging higher prices. These concerns have increased with the growth of the waste and recycling industries, the potential financial gains for producers, and the

welfare losses for society that result from anti-competitive behaviour. Lack of transparency has reinforced these concerns. This has prompted intervention by competition authorities and to the emergence of EPR schemes with multiple rather than single PROs. Competition authorities have also addressed some forms of anti-competitive behaviour in PROs that are vertically integrated with waste management providers. Continued vigilance is needed to ensure that the product markets that EPR systems serve remain competitive, and are efficient and effective in managing post-consumer products.

Box 3.5. **Japanese EPR for home appliances**

The Japanese Act for Recycling of Specified Kinds of Home Appliances came into force in April 2001. It aims to achieve a reduction in the volume of waste and to improve material recovery from four categories of home appliances: air conditioners; TV sets; electric refrigerators and freezers; and electric washing machines and clothes dryers. Under the act, each home appliance manufacturer must take back and recycle their products when they become waste.

To implement their obligations, manufacturers have set-up two competing groups, each bringing together three or four of the most important producers and representing a similar share of the market. One of the groups has set-up its own recycling facilities, while the other contracts with existing operators. Consumers and businesses disposing of home appliances have to pay both a collection or transportation fee and a recycling fee. Traceability is ensured by the use of recycling tickets (manifests) that are issued to consumers who pay the recycling fee. This manifest system ensures that waste home appliances are delivered to the original manufacturers of the products.

While there is no differentiation in the costs of managing individual brands within each of the producer groups, producers have an incentive to achieve cost savings through efficient processing or product design. Hence, there is competition between the two manufacturer groups to minimise recycling costs. Vertical integration creates a strong link between downstream management of end-of-life products and the producer. There is some empirical evidence that the system provides tangible incentives for eco-design.

Source: OECD (forthcoming a).

EPR systems in emerging economies are a relatively new phenomenon that was not covered in the 2001 OECD guidance manual (OECD, 2001). In these countries, a large number of informal waste workers – estimated at a total of 20 million – are involved in recycling end-of-life products with a positive economic value. The informal sector is usually relatively small in

OECD countries and often interferes negatively with well-functioning formal waste management systems e.g. by illegally removing high-value products and materials from the waste stream. However, in emerging economies informal workers often perform functions that are not provided by the formal waste management systems; for example, collecting end-of-life products and recovering the material from them. Thus, the introduction of an EPR system in emerging economies may threaten the livelihoods of informal waste pickers. The challenge is to find ways to integrate these workers in the formal waste management systems characterised by well-defined standards, while mitigating the adverse economic, environmental, health and social risks to which they are exposed. The 2015 OECD updated guidance manual (OECD, forthcoming a) provided guidelines on how this could be done (see Annex C).

Policy guidance on strengthening extended producer responsibility*

Ensure that EPR systems operate according to good governance principles (as described in OECD 2001 and forthcoming a).

Ensure that EPRs improve their transparency and disseminate better information with a view to making them more accountable, improving their performance and identifying good practices.

Enhance the effectiveness of EPR systems, including by increasing their level of ambition, broadening the scope of products covered, better internalising environmental costs, and strengthening enforcement.

Strengthen incentives for eco-design, including by ensuring that producers bear the full end-of-life costs of their products, linking EPRs with broader innovation initiatives and, in the case of globally traded products, by harmonising environmentally-sensitive design features.

Continue to involve competition authorities in overseeing the operation of EPR systems.

In emerging economies, identify opportunities for integrating informal workers in formal waste management systems when they can play a positive role, while mitigating adverse economic, environmental and social risks associated with waste picking.

* Comprehensive OECD policy guidance on EPR is provided in Annex C.

3.2.2. Green public procurement

In 2002, the OECD adopted a *Recommendation of the Council on Improving the Environmental Performance of Public Procurement* (OECD, 2002); in 2007, the Secretariat published a report (OECD, 2007b) to assess the progress on the implementation of measures contained in the Recommendation.

In this report, Green Public Procurement (GPP) is defined as a set of "procurement policies for which environmental criteria are explicitly applied in the procurement decision-making process." (OECD, 2007b: 2) The objective of introducing such criteria in the procurement process is to shift public purchasing towards goods and services which are less environmentally damaging throughout their whole lifecycle.

More recently, the OECD adopted the *Recommendation of the Council on Public Procurement* (OECD, 2015e) to encourage the use of procurement as a strategic tool for good governance. It includes guidelines on how to integrate secondary policy objectives, including green growth, into public procurement programmes. According to OECD (2015f), today 84% of OECD countries have policies encouraging green procurement at the central government level.

Green public procurement provides a potentially important instrument for shaping consumption and production to support resource efficiency objectives. In OECD countries, general government procurement accounts for 12% of GDP – 20% in the EU – and nearly one-third of government expenditures (OECD, 2015g; OECD, 2015f; European Commission, 2015). If the criteria for public purchases reflect policy objectives for increased resource efficiency, they can serve as important drivers for innovation, providing industry with incentives for developing greener products and services. This practice can be particularly impactful in sectors where public purchasers represent a large share of the market, such as construction, health services and public transport.

However, reported obstacles to successful GPP implementation are:

- "the perception that green products and services may be more expensive than conventional ones;
- public officials' lack of technical knowledge on integrating environmental standards in the procurement process and
- the absence of monitoring mechanisms to evaluate if GPP achieves its goals." (OECD, 2015g: 4)

To address these issues, the Public Governance and Territorial Development Directorate of the OECD recently developed good practices

for GPP based on country case studies (OECD, 2015g). Some of the main findings and recommendations are summarised below:

1. *A solid GPP framework*. Such frameworks – which may include regulation and policy guidance for public purchasers – can be powerful tools for directing public purchases in line with green goals. Regulatory frameworks rely on a variety of tools, from guidelines to schemes to increase "market-pull" that incentivise the development of green solutions. Well-aligned policies can help to reaching GPP objectives; for example, policies for green growth, green procurement, eco-labelling and eco-innovation should be consistent and, where appropriate, co-ordinated. The GPP framework should provide for decisions to be taken on the basis of a comparison of the lifecycle costs of alternative products; if not, goods and services that have lower initial costs but higher life-time costs will be selected. At the same time, the GPP framework needs to be non-discriminatory between domestic and foreign sources.

2. *Understanding the factors that can help and hinder the uptake of green goods and services*. Opposition to GPP can be overcome by communicating the results of lifecycle analysis in a way that shows the overall benefits of using greener products, particularly when the up-front costs are higher than those of competing products. At the same time, canvassing the views of suppliers can help to understand possible options, define realistic performance standards, and stimulate research and innovation.

3. *Introducing environmental standards in the technical specifications, procurement selection and award criteria, as well as in contract performance clauses*. It is difficult to implement GPP without credible standards to identify products or services that are "green". EU studies show that the uptake of GPP has been strongly influenced by eco-labels for different product categories. Using functional performance-based criteria rather than specifying design features encourages the development of lower-cost, innovative approaches. It is important to include environmental requirements at all stages in the procurement process, from design to implementation. An example is illustrated in Box 3.6, explaining how the Netherlands have integrated lifecycle analysis in green public procurement.

4. *Professionalising GPP and increasing know-how and skills*. GPP requires specialised knowledge and skilled multidisciplinary teams. The capacity of the public sector to use procurement strategically can be built up using tools like manuals, training and guidance. Procurement teams should involve experts with the range of skills required to manage the process, such as lawyers, scientists,

engineers, and economists. Some countries have established channels for dialogue between the government, front-runner companies and purchasing units with the goal of constantly improving GPP policy. In decentralised administrations, it is particularly important to engage sub-national levels of government and to support them to build their capacity to carry out their tasks.

5. *Raising awareness on GPP solutions and their benefits with buyers, businesses and the civil society.* A focused effort on getting the right messages across to government procurement officials, potential suppliers and the general public can have a significant impact on the success of GPP. Amongst other things, it can encourage businesses to develop green solutions and increase citizens' trust in the achievements of green policies. Dedicated webpages, stakeholder dialogue, public events and conferences are tools used to communicate about GPP. However, there is scant information on the impact of these efforts.

6. *Monitoring the results of GPP.* Monitoring provides a basis for evaluating and adjusting GPP policies. Countries appear to have adopted a variety of approaches to monitoring: some are simply descriptive; others are calibrated against targets or forecasts; and some aim to assess impacts. Some countries have developed reporting requirements.

Box 3.6. **Integrating lifecycle analysis in green public procurement: The case of the Netherlands**

Despite the 2002 OECD Council Recommendation recognising the importance of lifecycle analysis (LCA) in GPP, only 16% of OECD countries apply this approach systematically. The Netherlands has tried to address this challenge in part by developing a software tool, DuboCalc, that calculates the environmental impact of construction materials. It calculates the embedded environmental impacts of material use, from raw material extraction and production up to and including demolition and recycling. It also calculates the energy consumed by infrastructure works during the use phase.

DuboCalc incorporates information on the amounts of materials used for various designs. Using LCA data from a built-in database, it calculates 11 environmental impact parameters. It then uses shadow prices (of avoided emissions) to calculate the Environmental Cost Indicator (ECI). The ECI is converted into a monetary value which is a measure of the avoided environmental impact that can be compared with the total cost of the project. The contracting authority may then use the most economically attractive option (MEAT) criterion to identify the preferred tender in a way that takes into account resource efficiency.

Box 3.6. **Integrating lifecycle analysis in green public procurement: The case of the Netherlands** *(continued)*

On completion of the work, the contractor must demonstrate that the proposed ECI value has been achieved. If not, the contracting authority may impose a penalty of 1.5 times the underachievement. So if an ECI value of EUR 5 million was not achieved, the contracting authority would pay the contractor EUR 7.5 million less than the submitted quote price.

An important advantage of this approach is that it allows the contractor freedom to develop an innovative design. At the same time, monetising the reduced environmental impact allows environmental factors to be considered in the framework of MEAT which is a commonly used criterion in public procurement. The main challenge is to develop a methodology that costs and weighs the environmental parameters in an appropriate way.

Source: OECD (2015g).

Policy guidance on strengthening green public procurement

Review the environmental criteria in GPP programmes to ensure that resource efficiency objectives are appropriately reflected and aligned with other government policies; more systematically base environmental criteria on lifecycle analysis.

Increase the impact of GPP on resource efficiency by effectively integrating resource efficiency criteria into all stages of the procurement process; tender specification, selection and implementation.

Build appropriate capacity in relevant agencies at national and sub-national level as appropriate, and establish effective inter-disciplinary teams to manage GPP.

Raise awareness of the benefits of GPP with purchasers, suppliers and civil society.

GPP clearly has important potential to increase the demand for green products. However, it is not clear to what extent this potential is being realised. Work by the OECD and UNEP (2012) have pointed to the weak evaluation of the impacts of GPP. Results of support for green public procurement are only measured in 69% of OECD countries (OECD, 2015f). Reasons for this are lack of data, of appropriate methodology, insufficient incentives, lack of financial resources, absence of legal requirements. Moreover, it is not clear how far the environmental criteria used in GPP

systems are aligned with resource efficiency objectives. Although GPP policies often acknowledge the importance of using lifecycle analysis (LCA) when evaluating environmental impacts, few OECD countries are actually implementing this approach in practice. In many countries, capacities to implement GPP should be strengthened and stakeholders more engaged.

3.2.3. Partnerships with business and other stakeholders

An OECD report (2008g) defined partnerships as voluntary arrangements involving the sharing of risks and benefits among partners, and combining and leveraging the financial and non-financial resources of partners towards the achievement of specific goals. Partnerships are a complement to traditional policy instruments that have frequently been advocated as a useful approach for dealing with the complexities involved in achieving resource efficiency along the product lifecycle. For example, the Netherlands has adopted a full lifecycle approach to manage seven priority waste streams that relies heavily on a partnership approach. A recent study has examined the various actions that could promote greater resource efficiency along the plastics value chain (World Economic Forum et al., 2016).

Within the OECD, a recent initiative has been taken within the framework of the Guidelines for Multinational Enterprises to promote responsible supply chains through co-operation among business partners. The Guidelines represent a commitment by adhering governments to provide an open and transparent environment for international investors and to encourage the positive contribution that multinational enterprises can make to economic and social progress (OECD, 2011e). Governments have used this framework to provide recommendations to enterprises in various areas. The recommendations are voluntary and intended to complement relevant laws and international standards. In order to help companies implement the recommendation of the Guidelines, sector-specific guidance has been developed for responsible supply chains in the minerals (OECD, 2013) and agricultural (OECD and FAO, 2015) sectors. A draft guidance document is currently under discussion on responsible supply chains in the garment and footwear sector, one of the largest consumer sectors globally with a significant environmental footprint (OECD, 2016b). The draft guidance recommends how a range of potentially adverse impacts should be assessed, managed and communicated. While it covers some environmental issues – the use of chemicals, water and energy – there is no linkage with resource efficiency policies more broadly. There may be an opportunity to bring these strands of work together.

Industrial symbiosis (IS) is another example of a type of partnership that can promote resource efficiency. Within the G7, the United Kingdom and Germany hosted a workshop on this issue in October 2015 (International Synergies, 2015). Lombardi and Laybourne (2012) reviewed experience in

this area and formulated the following definition of industrial symbiosis: "IS engages diverse organisations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations for non-product outputs, and improved business and technical processes" (Lombardi and Laybourne, 2012: 31-32). The classic example of IS is when one company's waste becomes another's production input. National and local governments often play an important role in facilitating the process. Universities can provide technical support. An assessment of the British experience suggested that the benefit/cost ratio of an initial five-year programme was between 32-53:1. The United Kingdom and Germany have supported the establishment of successful industrial symbiosis programmes in a wide range of countries. France has recently launched an initiative in this area. There appears to be opportunities to further extend and scale-up this approach.

While the objectives of a partnership may be more or less precisely defined, there are often a range of more-or-less unintended benefits attributed to partnerships, such as:

- *"Attitude change*: greater understanding and valuing of other sectors/ communities;
- *Networking*: the development of new, trusted connections;
- *Technology and knowledge transfer*: cross-partner transfer of technical and other skills and knowledge;
- *Human capital*: improved working practice and human capital development from exposure to different working methods and viewpoints;
- *Social capital*: an improvement in reputation (and hence a greater willingness for others to work with and/or trust an organisation);
- *Spin-off partnerships*: an increased interest, capacity and opportunity to build future successful partnerships." (OECD, 2008g: 10)

The costs of partnerships include both the direct human and financial costs associated with the project, including the communication and co-ordination costs. Costs and complexity will increase with the level of ambition. There may be unintended costs as well as unintended benefits. Ideally, to demonstrate the value added of a particular partnership, it would be desirable to compare the benefits and costs with an alternative approach. The outcomes of partnerships, the costs and benefits involved, should be evaluated to learn lessons for the future. Many partnerships are not subject to such evaluation.

Governments will view partnerships as complements, not alternatives, to public policy instruments whereas private companies will only engage in

partnerships when they cannot achieve their objectives by themselves, and when there is a clear business case for such an engagement. Partnerships are not a panacea: they are not appropriate in all circumstances and even where they are used, some will fail, as any project can fail. As Box 3.7 illustrates, there are often substantial challenges to overcome when engaging in ambitious partnerships.

Box 3.7. **Phosphate value chain agreement in the Netherlands**

To supply its large agriculture sector with phosphates, the Netherlands is dependent on imports from China and Morocco. Steep price increases in the late 2000s led to concerns about a supply shortage. To address this, a number of Dutch stakeholders promoted the idea of "mining" secondary phosphate, for example from wastewater and manure. An additional benefit was that such an approach could help the Netherlands reduce pollution in rivers and lakes from excess phosphate. In 2011, the government brought together 20 water, chemical, food industry and agricultural stakeholders in a Nutrient Platform with the goal of making the Netherlands a net exporter of secondary phosphate. The "Phosphate Value Chain Agreement" was signed in the same year.

There were a number of challenges to be overcome to promote co-operation, including: bringing together stakeholders along the value chain that do not normally work together; promoting trust among parties who might not benefit equally from co-operation efforts; absence of any government incentives (such as subsidies); legislation on the use of recovered material containing heavy metals (which was amended).

Another challenge was to promote investment in the secondary phosphate market in the context of highly volatile commodity prices. The price of phosphate rock rose from USD 50 to USD 450 in 2007-08 as a result of supply issues in China. The price then fell to USD 100 in late 2009. The price volatility created an uncertain and risky environment for investment. To address this, the Nutrient Platform sought to facilitate co-operation between companies and financial institutions with the objective of fostering innovation in the sector.

An additional complicating factor was the significant drop in the use of phosphorus per hectare (ha) in the Netherlands; from almost 40 kg/ha in 1990-92 to just over 10 kg/ha on average between 2007-10. The impact of this decline on the development of the Phosphate Value Chain Agreement is unclear.

While the outcome of this agreement is not yet final, it provides an example of innovative approach to promoting resource efficiency along a value chain through stakeholder co-operation and without state subsidies. It also illustrates some of the challenges that may arise.

Source: OECD (2015h).

OECD (2008g) identified a number of factors that can help partnerships succeed:

- "A *positive enabling environment*; such as appropriate government policies/legal frameworks or the existence of appropriate institutions to bring partners together;
- A focus on *important needs* that can be best fulfilled through partnerships and that are recognised and accepted by all partners;
- A clear understanding of the *objectives* of the partnership, and the tasks to be carried out, involving all parties, ideally the objectives should be specific, measurable, agreed, realistic and time-bound (SMART);
- A result-oriented and appropriately *detailed plan* for achieving the goals and targets set up jointly for the partnership, with clear allocation of responsibilities;
- Clear understanding of *mutual benefits* (win-win) for all involved parties, as well as the incentives that motivate each to achieve the agreed objectives;
- *Effective relationships and communication* built on mutual respect and understanding and a shared commitment and ownership by all partners; this requires patience and time;
- Sufficient and appropriate human and financial *resources* committed from all partners;
- Good *leadership* which could include competencies in facilitation and change management; the leadership roles need to be clearly defined and there should be recognition that they may change with time;
- Clear and enforceable lines of *accountability*; this can involve adhering to agreed standards or procedures, sharing information on decisions, actions and performance, and justifying publicly why decisions were made;
- *Flexibility* is vital; there is no one-size-fits-all approach;
- Accurate and appropriate *indicators* to be used to evaluate, inter alia, progress in achieving the goals of partnerships and costs involved;
- Constant and effective *monitoring, measuring and learning*." (OECD, 2008g: 17)

Policy guidance on partnerships with the private sector and other stakeholders

Consider partnerships when government, private companies and other stakeholders recognise that they cannot achieve important resource efficiency objectives by themselves, and when there is a clear business case for such an engagement; ensure that an effective, flexible governance arrangement is established, including a system for monitoring progress.

Further develop, broaden and scale-up successful partnerships, for example in the area of industrial symbiosis.

Explore how resource efficiency considerations could be better integrated into OECD work on responsible supply chains.

3.3. Treat resource efficiency as an economic policy challenge and integrate it into cross-cutting and sectoral policies

G7 countries are increasingly approaching resource efficiency as an economy-wide issue, sometimes in the context of green growth or sustainable development strategies. Some countries are committed to developing a circular economy where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised. There is some evidence (Dubois, 2015) that pursuing this goal could help to boost competitiveness, guard against scarcity of resources and volatile prices, and help to create new business opportunities and innovative, more efficient ways of producing and consuming.

Even though there are important differences between the policy areas, approaching resource efficiency as an economic challenge provides opportunities to draw on some of the analytical and policy approaches that have been applied to climate change. Indeed, there are important synergies between climate and resource efficiency policies which should be exploited. The potential GHG reductions from efficiency improvements are particularly pronounced when resource flows are associated with the production of basic materials such as cement, steel, chemicals and paper (OECD/IEA/NEA/ITF, 2015). The products, by-products and wastes (and the resource streams they compete with) of these industries all contain large amounts of embedded energy and GHG emissions, so resource efficiency gains in these activities can result in proportionally large GHG emission reductions.

At the overall governmental level, resource efficiency can be mainstreamed into public policy by:

- Aligning policies so as to reduce pressures from the major resource-consuming sectors such as agriculture and food, transport and energy.
- Integrating resource efficiency into cross-cutting policy domains that provide opportunities for structural economic change.

3.3.1. Align sectoral policies with resource efficiency objectives

Sectoral policies may stimulate inefficient use of resources. A recent OECD study on climate change identified five areas where policy misalignments can occur (OECD/IEA/NEA/ITF, 2015), which are also relevant from the point of view of resource efficiency:

- **Policy areas and policy objectives.** Is there consistency between goals, objectives or impacts of existing policy areas and resource efficiency policies? For instance, do financial market regulations have unintended negative consequences for resource efficient investments? Are tax systems encouraging resource inefficient development?
- **Development, economic and industrial policy goals.** Are policies that support development goals undermining long-term resource efficiency goals?
- **Levels of government.** Are the respective mandates of different levels of government and different ministries conducive to or hindering resource efficiency objectives?
- **Stakeholders.** Do public and private actors have the same incentives for transitioning to the circular economy – e.g. are potential risks related to resource scarcity transparently reflected in corporate disclosures and investor portfolios?
- **Borders.** Can one country's resource efficiency policy be undermined by another's domestic policy choices? Do international trade rules or unilateral trade remedies hinder the adoption of stronger resource efficiency policies? If so, how?

In order to further develop this type of analysis, governments should conduct sector-by-sector analyses of policy misalignments in order to identify the most important drivers of resource inefficiencies and ways of addressing them. Some G7 countries are already examining sectors such as food, plastics, construction, textiles and electrical and electronic equipment. In addition, international organisations such as the OECD have also developed

sector-specific analyses, for example to identify policy misalignments in the broader investment environment for renewable energy, or to assess the impact of local-content requirements and other trade measures on renewable energy investment and trade (OECD, 2015i, 2015j, forthcoming b). The opportunities and challenges will vary according to the sector, the situation in the country concerned and the value chains involved. Checklists could be developed to assist countries carry out their diagnoses of specific sectors.

Box 3.8. **Policy misalignments in the context of sustainable mobility**

Sustainable mobility has been identified as a priority by several G7 countries. The reasons are clear: the transport sector generates 23% of global CO_2 and is the fastest growing source. It also generates adverse health impacts (due to local air pollution), and economic costs (due to congestion). The production of cars consumes significant amounts of metals and other materials. Road infrastructure requires large volumes of concrete and other materials, and results in land coverage and loss of biodiversity.

The transition to sustainable mobility is based on 3 main pillars:

- Reduce demand for vehicle usage;
- Promote the transition to low-emission, resource-efficient transport modes;
- Improve the carbon, energy and material intensity of fuels and vehicles.

While the way forward is well-understood, there are formidable barriers that prevent progress, and which lock transport systems into their current carbon-, energy- and material-intensive structures. Some of these barriers stem from policies and arrangements in non-environmental sectors. These may include:

- Lack of co-ordination between authorities responsible for land-use and transport resulting in urban sprawl and increased road infrastructure and vehicle usage;
- Mismatches between administrative boundaries and the functional extent of metropolitan areas leading to unco-ordinated development of transport systems;
- Perverse incentives from national governments for urban authorities to invest in road and other infrastructure;
- Tax incentives for company cars encourage the purchase, and greater use of, larger more polluting vehicles;
- Existing regulations prevent the development of car sharing arrangements.

Source: OECD/IEA/NEA/ITF (2015), Ellen Macarthur Foundation et al. (2015).

Identifying policy misalignments is a necessary but not sufficient condition for promoting resource efficiency: a variety of other policy instruments should also be applied. For example, in the sustainable mobility context, incentive schemes could be set up to encourage walking (e.g. in pedestrian areas), cycling and public transport (see Box 3.8). However, the effectiveness of these policy instruments may be undermined unless policy misalignments are addressed.

Policy guidance on mainstreaming resource efficiency in public policy

Integrate resource efficiency into national economic development strategies, including sustainable development and green growth strategies.

Develop synergies with climate change and other policies; integrate resource efficiency into Intended Nationally Determined Contributions; where appropriate, draw upon experience gained from climate change policies to identify ways of mainstreaming resource efficiency in economic policies and strategies.

Analyse key resource-consuming sectors with a view to identifying and rectifying any policy misalignments with resource efficiency.

3.3.2. Integrate resource efficiency into cross-cutting policy domains

The transition to a resource-efficient economy is closely linked with broader policy objectives of making national economies more productive and competitive. Governments have a number of policies at their disposal to steer economic development, and they should consider how they could be designed to support resource efficiency. This section examines three sets of policies: innovation, investment and managing the employment and skills dimensions of the transition. Governance arrangements are also considered. International trade, including export credits, and official development assistance are other important cross-cutting policy domains relevant to resource efficiency that merit further analysis: they are briefly discussed in section 3.5.

Promote resource efficiency through innovation

Innovation is a vital means to decouple economic growth from resource consumption and to promote green growth (OECD, 2011c; OECD/IEA/NEA/ITF, 2015). All G7 countries have programmes to support innovation in resource efficiency. In some cases, this applies both to technologies and to business models. 65% of the respondents to a 2011 survey of sustainable management policies in OECD countries indicated that the innovation dimension of their programmes was focused primarily on waste and products

(OECD, 2014a). More upstream parts of the value chain did not receive the same attention, at least not from public policies.

Business is the main driver of innovation but governments also have an important role to play. This stems from two basic market failures.

First, markets fail to internalise the costs associated with pollution or the drawdown of resources. These externalities are addressed by environmental policies that aim to internalise these externalities. The policy instruments that governments use for this purpose have been reviewed in section 3.1. When well-designed, they can provide incentives to comply with environmental requirements through innovation.

Second, firms face difficulties in fully capturing the benefits of their investment in R&D. This results in a socially sub-optimal level of research and innovation and policy measures to spur innovation are justified to bridge this gap. These policies include public investment in basic research, various support measures to encourage private investment in applied R&D, protection of intellectual property, support for public-private co-operation and various other measures.

Public support for R&D is one of the main ways that governments can help to generate the knowledge that underpins innovation. This raises the questions of how much should be invested and in what areas.

While public support related to innovation and climate change has been analysed (OECD/IEA/NEA/ITF, 2015), no equivalent studies appear to have been carried out for resource efficiency. More broadly, analysis of innovation policy shows that the financial crisis has resulted in cuts in research budgets: since 2008, OECD countries' gross public expenditures on R&D grew at half the annual rate observed in 2001-08. In the same period, business expenditures on R&D grew at about a quarter of the rate since in 2002-08. The share of R&D allocated to the energy sector fell from about 10% to 5% over the last 40 years. Given this context, it seems unlikely that the overall level of R&D related to resource efficiency has increased or even stayed the same in recent years. While R&D is an imperfect indicator of innovation – it only accounts for one of the inputs to the process, not the output – it nevertheless is a statement of intent. It would be helpful to have better insights into how resource efficiency is integrated into national research policies and how effective such initiatives have been.

Innovation for resource efficiency can come from a wide variety of sources. Given the uncertainty that this entails, it makes most sense for governments to support basic, long-term, riskier research that has a public goods character and that is unlikely to be undertaken by the private sector. This could include support for new interdisciplinary and trans-disciplinary research fields. Generally, governments should avoid supporting specific technologies.

Governments can use various tools to leverage business R&D. On the supply side, they can offer direct support via grants or procurement or use fiscal incentives such as R&D tax incentives. Market-based tools have the advantages of helping to reduce the marginal cost of R&D activities, and providing firms with the flexibility to decide which projects to fund. However, they also have shortcomings. The benefits depend not only on R&D expenditures, but also on the firm's profitability. This may mean that small, new companies not yet showing a profit may not benefit. Yet these firms are often the source of radical innovations. Some countries have recognised this pitfall and included provisions for such companies to "carry over" their benefits until they are profitable. Some resource efficiency programmes, such as the European Commission's Green Action Plan for SMEs (Box 3.9), have also sought to overcome some of these challenges by focusing support on SMEs.

Box 3.9. **Green Action Plan for SMEs in Europe: Main objectives and actions**

The European Commission has adopted a plan to assist SMEs to turn environmental challenges into business opportunities. It comprises the following objectives and actions:

Greening SMEs for more competitiveness and sustainability

- Provide practical information, advice and support;
- Support efficient technology transfer mechanisms;
- Facilitate access to finance.

Green entrepreneurship for the companies of the future

- Promote all forms of eco-innovation, including non-technological eco-innovation;
- Facilitate business partnering, skills and knowledge for green entrepreneurship;
- Exploit better the role of clusters in support of eco-innovative SMEs.

Opportunities for SMEs in a greener value chain

- Address systemic barriers to cross-sectoral and cross-national value chain collaboration and business creation and co-operation;
- Facilitate cross-sectoral collaboration.

Box 3.9. **Green Action Plan for SMEs in Europe: Main objectives and actions** *(continued)*

Access to markets for green SMEs

- Facilitate access to international markets;
- Facilitate the uptake of resource efficiency technology in partner countries.

Governance

- Monitor and update actions;
- Co-ordinate and exchange of best practices at European, national and regional level.

Source: European Commission (2014).

Governments can play a valuable role in bridging the gap between basic and applied research by fostering co-operation between firms (both small and large) with universities. They may also promote international research co-operation and contacts with financial institutions. However, the closer, governments get to applied research and market commercialisation, the greater the risk they will have to make policy bets on specific technologies. One strategy to reduce the risk is to prioritise support for innovation with broad potential applications. For example, targeting R&D public support at storage technologies rather than at specific renewable energy technologies could be preferable for two reasons: it is less burdensome in terms of information requirements for governments, and it targets early-stage technologies with important network externalities, which are likely to attract suboptimal levels of private investment (Johnstone and Haščič, 2012). Provision of targeted support for specific technologies requires continuous evaluation in order to ensure that any government expenditure continues to provide value added in achieving the established policy objective.

As Box 3.10 illustrates, some governments support companies to make the transition from R&D to the market through financial support and advisory services. Governments can also support the diffusion and take-up of resource efficient technologies by using demand-side innovation policy measures. These include public procurement (discussed in section 3.2.2), information dissemination (e.g. through environmental technology verification schemes), advanced market commitments, technology prizes and instruments to change consumer preferences.

Box 3.10. **Promoting resource efficiency innovation in Canada**

Sustainable Development Technology Canada (SDTC) funds Canadian clean tech projects and coaches the companies' managers as they move new technologies to market. It also develops and supports networks of partners from industry, academia and government, from home and abroad. The Canadian government has allocated CND 915 million to SDTC and this has leveraged CND 1.8 billion from partners. It has supported 269 projects in the energy, transport, agriculture, forestry and waste sectors. The Canadian cleantech sector consists of over 800 companies, mostly SME. It employs 50 000 people and has revenues of CND 12 billion.

The Canada Mining Innovation Council (CMIC) is a national non-profit organisation that co-ordinates innovation projects and programmes in response to "life of mine" challenges defined by its more than 80 industry-wide members. The CMIC Zero Waste Initiative will develop innovation priorities that will lead to significant reductions in mining waste in the next 5 years. The aim is to move towards net zero waste in mining and mineral processing in 10-20 years. These end points would be staged through more efficient definition of new ore discoveries, more effective *in situ* mining methods to minimise waste rock production, closed system processing to reduce water and energy waste, and refinement of mine tailings towards a benign, saleable product.

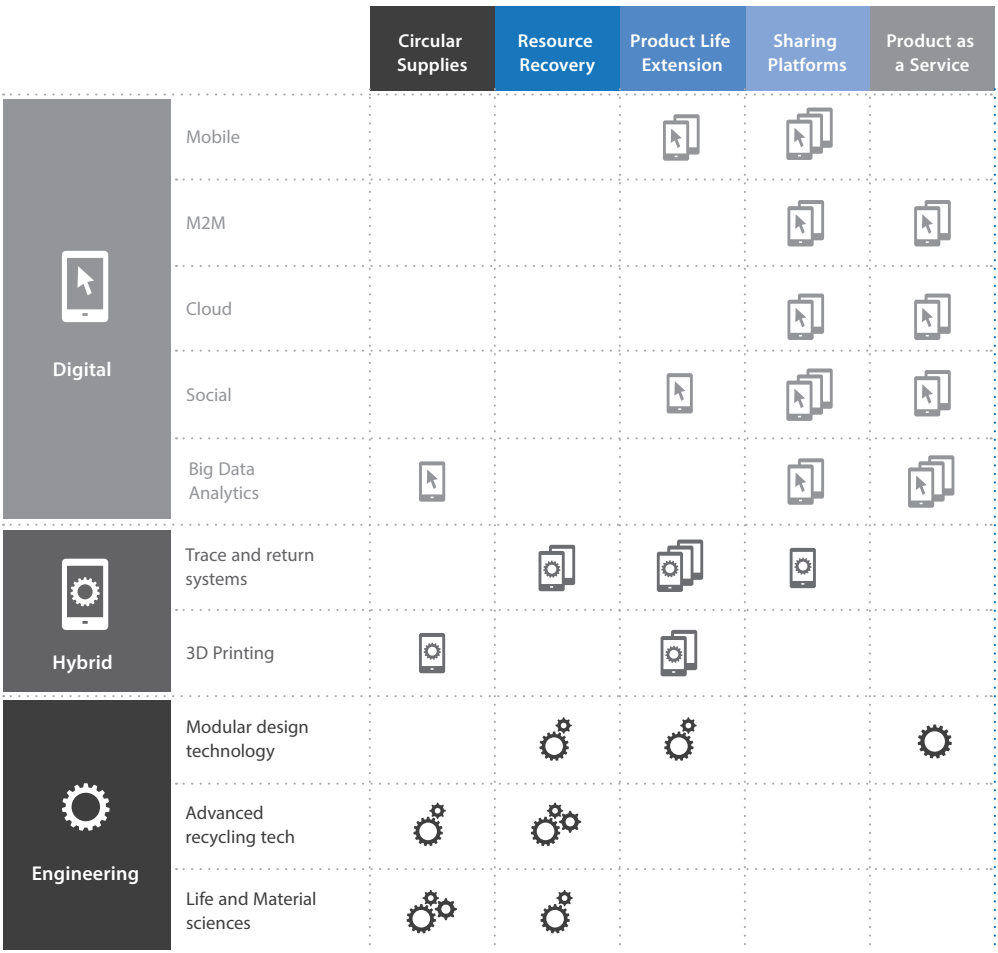
Source: Pearson (2015), Sustainable Development Technology Canada (2016).

An important dimension of innovation for resource efficiency is the development of new business models (OECD, 2013). A study by Accenture Strategy (2014) analysed 120 companies that are generating resource productivity improvements in innovative ways. It suggests that while initially disruptive business models were driven by start-ups, larger multinational companies are now also involved. On the basis of its analysis, Accenture identified five underlying business models for the circular economy:

- *"Circular Supplies*: Provide renewable energy, bio-based or fully recyclable input material to replace single-lifecycle inputs;
- *Resource Recovery*: Recover useful resources/energy out of disposed products or by-products;
- *Product Life Extension*: Extend working lifecycle of products and components by repairing, upgrading and reselling;
- *Sharing Platforms*: Enable increased utilisation rate of products by making possible shared use/access/ownership;
- *Product as a Service*: Offer product access and retain ownership to internalise benefits of circular resource productivity." (Accenture Strategy, 2014: 12)

Accenture Strategy also suggested that many or most of the new business models would not be possible without the support of innovative new technologies. Their research identified ten disruptive technologies in three categories: digital (information technology), engineering (physical technology) and hybrids (combinations of the two). Figure 3.2 outlines the potential of these disruptive technologies for circular business models.

Figure 3.2. **Disruptive technologies used by pioneers to launch and operate circular business models with speed and scale**



Note: Based on 120+ case studies and 50+ interviews. Number of icons in respective boxes indicate relative importance.

Source: Accenture Strategy (2014).

While these innovations are primarily driven by the private sector, government may also have an important role to play in ensuring that regulatory requirements do not unnecessarily impede the development of new, resource-efficient business models. However, as the conflicts over new taxi services, accommodation, and music streaming illustrate, the incumbents in established markets may oppose new business models that threaten their revenue sources or market share. Thus, the regulation of new business models may involve some difficult trade-offs.

Policy guidance on resource-efficient innovation

Integrate resource efficiency into national innovation policies and regularly assess the results achieved.

Prioritise basic, longer-term, riskier research in public R&D programmes, and provide support for interdisciplinary initiatives.

Avoid policy measures that create barriers to the entry of new firms to markets; establish an enabling environment to facilitate innovation and the take-up of resource-efficient products and processes in SMEs.

Promote research partnerships involving the private sector, universities and the government; any support for specific technologies should favour those with a potentially broad range of applications.

Remove any unnecessary regulatory barriers to the development of new resource-efficient business models.

Align investment policies with resource efficiency objectives

Irrespective of concerns about climate change or resource efficiency, the global economy requires around USD 90 trillion of investment in infrastructure (e.g. buildings, transport, energy) between 2015 and 2030 to support economic growth and the broader development agenda (OECD, 2015l). In advanced economies, many ageing infrastructure networks for water, energy and transport need to be replaced or upgraded. In emerging and developing economies, most of the infrastructure required to meet development goals is still to be built, particularly in urban settings.

In confronting this challenge, climate and resource efficiency policies are closely aligned. There is an important window of opportunity to ensure that new investment in infrastructure helps to support both low-carbon and resource-efficient development. Failure to seize this opportunity will reinforce the carbon and resource intensity of economies. Analysis conducted

on climate change suggests that the incremental short-term costs of low-carbon infrastructure investment would amount to just a fraction of the finance needed for infrastructure overall. Moreover, these additional costs are small compared with the cost of the potential impacts of climate change if this action is not taken.

According to the World Economic Forum (2014), global spending on basic infrastructure – transport, power, water and communications – amounts to USD 2.7 trillion a year, a shortfall of about USD 1 trillion compared with assessed development needs. An important factor in this shortfall is the cut-backs in public budgets following the global financial crisis. Public investment per capita in 2012 fell in 15 out of 33 OECD countries, compared with 2007. Public financing alone will not be enough to bridge the investment gap. Rather, this transition will require the large-scale mobilisation of all sources of private sector investment and finance. Governments should target the scarce resources available for infrastructure investment at activities unlikely to attract sufficient private funding and at leveraging large-scale private sector investment. They should also set an example by ensuring that public investments are resource-efficient (see discussion on green public procurement in section 3.2.2).

Traditional sources of private capital, such as commercial banks, are facing increasing constraints to supporting long-term investment due to tightened financial regulations and the need to reduce debt. This has stimulated interest in other sources of private capital, notably institutional investors. With USD 92 trillion of assets under management in OECD countries in 2013, institutional investors such as pension funds, insurers and sovereign wealth funds could play a significant role in driving long-term investments in a low-carbon, resource-efficient economy.

Although institutional investors have increased their equity and debt investment in low-carbon projects in recent years, these investments represent a small fraction of their assets. Looking at large OECD pension funds only, direct investment in infrastructure projects of all types accounted for 1% of their asset allocation in 2013. “Green” infrastructure is estimated to account for an even smaller share. Too many barriers still stand in the way of scaling-up the participation of institutional investors. However, if and when they did increase allocations towards infrastructure investment, it would be important that the benefits of resource-efficient investment were recognised in their investment strategies.

Current levels of low-carbon and resource-efficient investment fall short of a development pathway compatible with the transition to a green economy. Of the USD 1 600 billion of global energy investments in 2013, 70% was in the extraction and transport of fossil fuels, oil refining and construction of fossil fuel power plants

National economies encompass a range of market and policy failures that collectively favour investment in carbon- and resource-intensive activities, often unintentionally (OECD, 2015i). These are either linked to the enabling environment in specific sectors of the economy, or to the functioning and

Table 3.4. **Examples of policy misalignments that undermine low-carbon investment**

Business environment	Fiscal policies	• Insufficient carbon pricing and incentives for low-carbon technologies • Environmentally harmful subsidies and incentives (e.g. fossil fuels) • Tax policies that unintendedly favour carbon-intensive behaviour (e.g. company cars)
	Climate policies	• Lack of ambitious international and national reduction targets or binding objectives • Lack of climate policy stability: retroactive changes in climate legislation
	Investment policies	• Regulatory barriers to international investment in low-carbon projects (e.g. limits on foreign ownership, restricted access to land, local content requirements) • Lack of transparency, insufficient investor protection and intellectual property rights protection in low-carbon technologies, weak contract enforcement
	Competition policies	• Lack of open and competitive infrastructure markets (e.g. in the electricity sector) • Market designs and regulatory rigidities that favour carbon-intensive infrastructure investment in the energy sector • Lack of a level playing field in the power sector for existing fossil-fuel producing state-owned enterprises and independent producers of clean energy
	Trade policies	• Trade barriers for low-carbon goods and services
	Public governance	• Lack of long-term goals for low-carbon infrastructure planning and procurement • Contradictory signals between national and sub-national climate objectives • Lack of stakeholder consultation in policy design
	Innovation	• Enforceable global intellectual property right regimes (potentially hindering the transfer of green technologies to developing countries).
Financial system	Financial market policies	• Potential unintended consequences of financial regulations on long-term financing • Financial incentives across the financial system favouring short-termism (remuneration practices, fiscal measures, performance appraisal) • Barriers to the deployment of innovative financial instruments for new types of investors (e.g. institutional investors)
	Business conduct	• Corporate reporting that does not reflect the climate risk (e.g. stranded assets) • Lack of a responsible investment code • Lack of clarity on fiduciary duty and stewardship with respect to environmental, social and governance issues
	Public finance and investment	• Ongoing support to carbon-intensive investments, nationally and internationally • Continued support of carbon-intensive investments in development finance • Lack of capacity

Source: OECD/IEA/NEA/ITF (2015).

provisioning of financial markets (Table 3.4). Together they mean that the risk-return profile of low-carbon, resource-efficient investments do not offer a sufficiently attractive risk-adjusted return compared with available alternatives. The updated OECD *Policy Framework for Investment* includes a section on investment for green growth, recognising that "green" investments require both strong conditions for private investment in general, coupled with specific policies aimed at improving the risk-return profile of green and resource-efficient investments (OECD, 2015k). Looking specifically at unlocking clean energy investments, the OECD has developed a *Policy Guidance for Investment in Clean Energy Infrastructure*, a non-prescriptive tool to help policy makers address misalignments and strengthen the enabling environment for investment in renewable energy and energy efficiency in the power sector (OECD, 2015i). Ongoing OECD research is also assessing empirically the impact of climate policies and of the broader investment environment – and especially of competition policy – on investment in renewable electricity generation in OECD and G20 countries (OECD, forthcoming b, c).

Policy guidance for promoting investment in low-carbon, resource-efficient infrastructure

Target the scarce public resources available for infrastructure investment at activities unlikely to attract sufficient private funding and at leveraging large-scale private sector investment.

Review investment policy frameworks with a view to identifying and removing obstacles to investment in low-carbon, resource-efficient infrastructure.

Set an example by ensuring that public investments in infrastructure are resource efficient; integrate resource efficiency objectives into standards for buildings and other infrastructure.

Incentivise private investors to integrate resource efficiency objectives into their investment policies.

Ensure that labour policies and education and training programmes support the transition to a resource-efficient economy

The transition to a resource-efficient economy will stimulate the emergence of some sectors and the decline of others. While this may or may not lead to a net increase in employment, it will change the skill profile of the workforce (OECD, 2012c). For example, there may be new jobs linked to the use of different materials in the building and transport sectors, while

there may be a decrease in employment in the extractive and heavy materials sectors such as cement and steel.

One factor that can smooth the transition is labour market institutions and policies that support the reallocation of labour from shrinking to growing firms and activities. Countries that have reconciled labour mobility with income security (achieving so-called flexicurity) are likely to have an advantage managing an efficient transition. Such policies also help to limit political opposition to green growth policies grounded in concerns about the economic dislocation they could imply.

Another measure that can help to smooth the transition is to adapt vocational education and training programmes in a timely way to changing skill demands. The need for training support is generally greater in SMEs than in larger firms with the capacity to organise their own training, as some electricity utilities have done for renewable energy. There may be a sectoral dimension. For example, the European Commission launched an initiative for the construction sector, starting with country-level evaluations of skills needs and gaps. It revealed that more than 3 million workers in Europe will require training by 2020, most in the form of continuous vocational education for existing workers. In a second phase, funding will be provided for large-scale qualification and training schemes. There may also be a regional dimension to the transition that requires dedicated measures.

Given the uncertainties, it would be prudent for governments to try to anticipate the evolving skill needs for a resource efficient economy. To date several G7 countries have made such assessments, though in different forms, e.g. by developing episodic studies of "green skills", systematically forecasting the emerging demand for such skills, or co-ordinating vocational education and training planning with the implementation of environmental policies and systematically green skills (OECD/IEA/NEA/ITF, 2015). Assessing how effective these initiatives have been in addressing skills gaps would provide valuable insights to further develop policy in this area.

Policy guidance on job skills for the transition to a resource efficient economy

Assess new job skill requirements for the transition to a low-carbon, resource-efficient economy and adjust education and training programmes accordingly.

Establish effective governance arrangements to promote a coherent approach to resource efficiency

Even when governments have established a national strategy for resource efficiency, they face a major challenge to co-ordinate policies given the variety of issues involved, the mixed track record of most governments in working horizontally, and the need to include an unprecedented range of public and private actors. The scales and time frames involved in the transition to a resource-efficient economy also make policy implementation and co-ordination particularly challenging.

Many OECD Members report that implementation of resource efficiency policies is hampered by the broad scope of resource productivity issues and the involvement of many economic actors in different sectors and in different locations in the supply, use and disposal chain (OECD, 2014a). As discussed above, achieving coherence, avoiding misalignments, and achieving reductions, not displacements, of resource consumption are all major challenges. It seems unlikely that efforts to co-ordinate policies will be successful if they do not operate at a sufficiently high level of government, and have the power to convene and guide the activities of all the major ministries involved.

Finland and the Netherlands are among the few countries that appear to have established an overarching mechanism to support co-ordination and coherence of resource productivity policies (European Environment Agency, 2011). France's Circular Economy Roadmap is also intended to support better co-ordination across policy areas (OECD, 2014a).

Governments have developed a variety of other solutions to promote more strategic co-ordination of cross-cutting policy objectives. These include establishing super ministries, policy "tsars", inter-ministerial committees, and independent policy units. The United Kingdom adopted one of the most far-reaching approaches to government co-ordination for climate change, involving legally-prescribed climate change targets that cut across electoral cycles, with implementation monitored by an independent review mechanism.

Governments have also sought to co-ordinate policies by providing guidance to ministries on how to take account of environmental or climate change in their decision-making. This has been done for instance for the appraisal of proposed public projects (OECD, 2015g), for conducting impact assessments (OECD, 2010), and for public procurement (as discussed in section 3.2.2).

Resource efficiency not only calls for new approaches to policy making within governments, but new forms of partnership with non-governmental actors. Indeed, most commentators consider that in view of its scale and complexity, the resource efficiency challenge can only be addressed by innovative new forms of collaboration. As discussed in section 3.2.3, business clearly has a key role to play, and governments are exploring new forms of

partnership that go beyond legal requirements and business-as-usual scenarios. Equally, cities are the locus of many innovative initiatives on climate change and related issues (OECD and Bloomberg Philanthropies, 2014). Governments are also engaging universities and consumers in resource efficiency initiatives.

Establishing effective systems for the governance of resources is much more challenging in countries that are rich in resources than in those that are primarily importers. Resource-rich countries must establish governance systems that cover a range of complex, sensitive issues, including: definitions of property rights, establishing an appropriate fiscal framework, determining how the benefits of resource exploitation will be distributed, including to local communities, and managing the environmental and social impacts associated with the exploitation of resources. The Revenue Watch Institute has developed an index to monitor resource governance in 58 resource-rich countries.[1] Its most recent findings indicate that mismanagement and corruption are widespread in many resource-rich countries (Box 3.11).

Box 3.11. **Resource governance in resource-rich countries**

The Resource Governance Index evaluates four key components of resource governance in each country: Institutional and Legal Setting; Reporting Practices; Safeguards and Quality Controls; and Enabling Environment. Based on its evaluation, the Index assigns a numerical score to each country and divides them into four performance ranges, ranging from satisfactory to failing. Out of 58 countries, only 11 were considered to have satisfactory governance arrangements. These included the three G7 countries included in the analysis: Canada (Alberta), United Kingdom and United States (Gulf of Mexico). The vast majority of countries examined exhibit serious shortcomings in resource governance. The governance deficit is largest in the most resource-dependent countries and directly affects nearly 450 million poor people. Nevertheless, there is evidence that good governance is possible even in countries where natural resources are economically and politically important.

Source: Revenue Watch Institute (2013).

Policy guidance on effective governance for resource efficiency

Establish effective mechanisms at a sufficiently high government level to promote a coherent approach to resource efficiency and review progress against policy objectives.

The centres of government should provide guidance to sectoral and other ministries on how to take account of resource efficiency in their decision making, e.g. project appraisal, public procurement, impact assessments.

3.4. Strengthen policy development and evaluation through better data and analysis

3.4.1. Strengthen data collection and analysis of resource efficiency

The previous sections have drawn on existing information and analysis to describe some of the main trends, possible future scenarios and policy measures for resource efficiency. However, many gaps exist. The development of more efficient and effective policies for resource efficiency, and the evaluation of their impact, should be supported by strengthening data collection, more in-depth analysis, and refining future scenarios on resource consumption. The recently adopted SDGs have reinforced the need for better data and indicators, as well as the importance of better co-ordination of these efforts internationally.

At the international level, several developments have supported internationally comparable material flow analysis, including:

- The OECD has developed a set of guidance and reference materials for measuring material flows and resource productivity (OECD, 2008b, c, d, e);
- The System of Environmental and Economic Accounting was jointly adopted as an international standard by the UN, the EU, FAO, the IMF, the OECD and the World Bank (United Nations et al., 2014);
- Material flow cost accounting was included in the International Organization for Standardization's set of environmental management standards (International Organization for Standardization, 2011);
- A mandatory requirement was established within the EU to report on material flows (European Union, 2011);
- The UNEP IRP has developed a comprehensive international material flow database, which includes upstream resource requirements of traded goods.[2]

At the national level, many OECD countries have now established material flow accounts and are developing indicators for resource efficiency. However, a recent review of OECD countries' progress in strengthening the information base for resource efficiency concluded that many of the positive developments stem from initiatives begun in the early 2000s (OECD, 2014a). Progress in complying with the information-related provisions of the 2008 OECD Council Recommendation on resource productivity (OECD, 2008a, 2014a) was considered to be insufficient. Some of the most important gaps identified were:

- Methods for assessing the environmental impacts of resource use throughout the entire lifecycle of materials and the products that embody them.
- International flows of materials, in particular flows of raw materials embodied in traded goods.
- Flows of materials that are important to a circular economy and the 3Rs, including flows of secondary raw materials (recycled materials) and of waste.
- Material resource use and productivity disaggregated by industry and by type of material, and information on the processing levels of the materials (raw materials, semi-finished products, finished products).
- Compatible international data for key materials and substances, including critical raw materials, environmentally harmful substances and substances that play a role in global biogeochemical cycles or raise global concerns.
- Estimates of the size and value of future urban mines.[3]

Finally, at the macroeconomic level, a number of studies have developed models to estimate the potential benefits of a transition to the circular economy. They generally show that substantial benefits would result. However, a review of some of these studies considered that the results were difficult to interpret as they had used innovative assessment methodologies that had not been documented or reviewed before (Dubois, 2015). Most of the macroeconomic forecasts rely on assumptions regarding the costs associated with the transition to a more resource-efficient economy.[4] At the same time, these studies generally do not take into account the benefits of avoided resource disruption and environmental damage that resource efficiency policies are intended to achieve. For both of these reasons, as also underlined in UNEP (forthcoming), the results of such forecasts should be interpreted with caution and as a lower bound estimate of resource efficiency benefits.

Improving the understanding of the economic aspects of resource efficiency should, therefore, form part of the effort to strengthen the data and analytical base for policy development and evaluation. Major policy proposals should be subject to a careful assessment to ensure that the additional costs entailed are justified by the benefits they deliver. When objectives have been set, alternative instruments for achieving them should be assessed with a view to selecting those with the least cost (OECD, 2008f).

3.4.2. Establish objectives and targets based on good data and robust analysis

There has been much discussion about the role of targets in resource efficiency policies. Four of the G7 countries have established economy-wide targets that, in one way or another, aim to decouple the use of resources from economic growth: France, Germany, Italy and Japan (Annex B). However, other G7 countries, and the EU as a group, decided against such an approach. This may have been due to doubts about the value of an aggregate, economy-wide approach covering all the materials in an economy, the difficulties of doing so, particularly for a diverse group of countries, or it may have been due to political culture and the way that decision-making is organised in different governance systems.

While there are different approaches to aggregate national targets, all G7 countries have set quantitative targets at the level of waste streams (e.g. food waste, construction and demolition waste), or related to the amount of recycling or reuse to be achieved. Targets have also been set for parameters such as the amount of materials or toxic substances used in products.

A recent OECD report on sustainable materials management (OECD, 2012a) identified several possible reasons for setting targets for resource efficiency:

- "Providing a future vision/inspiration for action;
- Co-ordinating actions among various actors;
- Providing a mid-term constraint as a bridge or means to encourage society to be prepared for a future expected reality;
- Providing a metric of success against which progress can be measured;
- As a signal of action on an issue." (OECD, 2012a: 86)

There is broad agreement that targets should be SMART:

- ***S****pecific* – target a specific area for improvement;
- ***M****easurable* – quantify or at least suggest an indicator of progress;
- ***A****ssignable* – specify who will do it; in some cases, "a" may also stand for "agreement" or "achievable";
- ***R****ealistic* – identify the results that can realistically be achieved, given available resources; "r" may also suggest "relevant";
- ***T****ime-bound* – specify when the result(s) should be achieved.

Establishing SMART targets requires a strong data and analytical base. If not, there is a risk that the information asymmetry that exists between government and business, whereby the latter has more information about its products than the former, will result in targets that simply reflect business as usual. At the same time, inadequate analysis can result in overly ambitious targets that are not achieved, undermining the credibility of the policy.

The economic implications of targets should be carefully assessed to ensure that benefits outweigh costs. This increases with importance as the level of the target increases. Economic analysis can also guide priority-setting. Targets that can be achieved at no cost, or at low cost, are the obvious priorities for short-term action.

Establishing and achieving objectives is not solely an information issue; it also requires a strong government commitment, active engagement of stakeholders, and a credible review process to monitor progress and adjust the target if needed. In Germany, for example, the economy-wide resource productivity target has been included in a set of sustainable development goals that are reviewed every 4 years by the Federal Statistics Office.

OECD (2012a) reviewed the various types of targets used in this policy context and assessed their advantages and disadvantages (Table 3.5).

Table 3.5. **Summary of target types and key advantages and disadvantages**

Type of target	Timeline	Focus	Accountability	Key advantages	Key disadvantages
Hard	Short (1-5 yrs)	Product or Material	Clear and enforced	Set a baseline Measurable Enforceable	Difficult to achieve agreement Information requirements Typically based on known opportunities
Soft	Short to Medium	Product System	Somewhat clear but flexible	Easier to achieve agreement Adaptable to new information Less stringent information requirements	Harder to enforce Less accountability Information requirements
Voluntary	Short to Medium	Product, Material or Product System	Various, generally clear but flexible	Easier to achieve agreement Adaptable to new information Less stringent information requirements Inspires action Flexible	Harder to enforce Less accountability Typically based on known opportunities

Table 3.5. **Summary of target types and key advantages and disadvantages** *(continued)*

Type of target	Timeline	Focus	Accountability	Key advantages	Key disadvantages
Strategic Objective	Long (10+ years)	Country or Market	Limited	Easier to achieve agreement Co-ordinate multiple programmes Inspires action Flexible Can be ambitious	Limited accountability Difficult to measure success

Source: OECD (2012a).

Policy guidance on strengthening policy development and evaluation through better data and analysis.

Strengthen the collection of data on material flows along the lines recommended by OECD (2014a).

Strengthen international co-operation on resource efficiency data with a view to supporting the establishment of an effective monitoring system for achieving the SDGs.

Strengthen the economic analysis of resource efficiency to provide further support for the development and evaluation of policies in this area; particular attention should be given to strengthening policy evaluation, and identifying and sharing lessons learned.

Develop more robust outlooks to assess the economic and environmental implications of the transition to a more resource-efficient, circular economy.

Strengthen analysis of how the rebound effect can affect future scenarios.

Continue efforts to develop indicators that can help to assess the contribution of natural resources to economic growth and productivity, and the sustainability of resource use.

Deepen the analysis of the economic costs and benefits of implementing resource efficiency policies, including the obstacles that need to be overcome.

Improve analysis of the environmental costs, and the economic benefits of managing them, along value chains.

When establishing resource efficiency targets, ensure that they are SMART (specific, measurable, assignable, realistic and time-bound), that benefits outweigh costs, and that they are embedded in an effective governance system.

3.5. Strengthen co-operation at the international level, including among the G7

Many of the measures that are required to support the transition towards greater resource efficiency need to be implemented by governments at the domestic level, but action at the international level is also important. As the globalisation of our economies continues and value chains increasingly span across numerous jurisdictions, there is an increasing need for co-ordinated approaches at the international level. The G7 can play an important role in this respect, including by supporting businesses in their supply chain management efforts, in addressing trade related obstacles, in using official development assistance to support resource efficiency efforts, improving environmental labelling and information schemes, as well as resource efficiency data and indicators more broadly.

While it is difficult for national governments to influence the way **supply chains** are managed due to their limited jurisdictional competence, this can be done more effectively at the international level. For instance, the OECD Guidelines for Multinational Enterprises (OECD, 2011e) are recommendations for responsible business conduct that 46 adhering governments – representing all regions of the world and accounting for 85% of foreign direct investment – encourage their enterprises to observe wherever they operate. Within this framework, OECD promotes responsible supply chains in a number of industrial sectors including the garment and footwear sector, agricultural supply chains and the extractive sector. The work includes developing due diligence guidance in order to promote the observance of standards of responsible business conduct to ensure that operations do not lead to adverse impacts and contribute to sustainable development (OECD, 2013, 2016b).

Trade and investment is another area of potential focus as international value chains are typically connected through trade and investments in goods and services and restrictions to trade and investments may affect the efficiency with which resources can be used. The OECD has identified export restrictions on raw materials as a source of friction and trade disputes among governments and trading partners affected by them. The OECD inventory of export restrictions on raw materials shows that more than half of the identified export restrictions are related to metal waste and scrap (OECD, 2014b), potentially leading to mis-allocations of these secondary materials, a weakening of metal scrap markets and reduced opportunities for material recovery. Similarly, restrictions to the trade of used products have been identified to potentially hamper reuse and remanufacturing activities, which could play an important role in establishing a circular, more resource-efficient economy. Trade in environmental goods and services also remains subject to numerous barriers, thereby hampering the diffusion of best available environmental technologies and reducing the scope and scale of resource efficiency improvements globally.

Official development assistance provided by the members of the OECD Development Assistance Committee accounted for more than USD 131 billion in 2015, and it is assumed that only a very small share of this currently provides support for resource efficiency improvements (OECD, 2015l). For instance, only about 0.3% is currently related to solid waste management (Lerpiniere et al., 2014). Significant effects could be achieved if resource efficiency was mainstreamed into development assistance more systematically, leading to more capacity development and technology transfer as is currently the case.

Another area of possible attention at the international level is that of **environmental labels and information schemes** (ELIS) that are increasingly used to encourage consumers to opt for less environmentally harmful products. Similarly, manufacturers aiming to green their supply chains often struggle to identify the exact material composition of parts and components that they procure, linked to a lack of information along the supply chain. The OECD dataset of environmental labels and information schemes shows a rapid increase in their implementation, with their number more than doubling between 2000 and 2012 (Prag et al., 2016). There are concerns that the multiplication of these schemes could lead to consumers and procurers finding it harder to distinguish good from bad labels; that firms may bear excess costs in certifying with many different labels; and that competition may drive down the stringency of standards as different information schemes bid for market share. They could also adversely affect trade by modifying market access or by shifting the balance of international competitiveness. A range of government and non-government stakeholders have recognised that the multiplication of labelling and information schemes is happening and there could be benefits of acting at the international level to seek harmonisation of labels and mutual recognition, leading to the elimination of duplication and reductions of costs across international markets.

Finally, international efforts could also benefit the development of better **resource efficiency data**, as well as more robust **economic analysis** of resource efficiency. As outlined in section 3.4.1, the OECD identified a number of data-related gaps and there are a number of issues that require international co-operation to ensure the compatibility of datasets and common definitions and methodologies. Similarly, there is a need for co-ordinated efforts to improve economic analysis of resource efficiency, an area that has received very little attention in research for the moment and where internationally co-ordinated research efforts could allow to move forward more quickly.

Notes

1. The Revenue Watch Institute merged with the Natural Resource Charter to form the Natural Resource Governance Institute in 2013.
2. This database is publicly available in UNEP Live and currently presents data until 2010, with plans to update it. The database was used in UNEP (2015) report and is will be at the core of a forthcoming UNEP IRP report on material flow analysis.
3. The idea of "urban mines" refers to anthropogenic (rather than geological) stocks of materials (OECD, 2015a). Such stocks may be either used in the economy or not, but in theory they are accessible. Analysis of this issue has mostly focused on metals which in principle can be recycled continuously.
4. One such common assumption is costless technical change.

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Annex A

Sustainable development goals and resource efficiency

The Sustainable Development Goals (SDGs) comprise 17 goals and 169 targets. Nine goals and 17 targets are presented below that refer directly to resource efficiency or sustainable use of resources. Many others refer more indirectly to resource efficiency.

Goal 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Target 2.4: By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Target 6.4: By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity.

Goal 7: Ensure access to affordable, sustainable and modern energy for all

Target 7.3: By 2030, double the global rate of improvement in energy efficiency.

Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Target 8.4: Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead.

Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Target 9.4: By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Target 11b: By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-30, holistic disaster risk management at all levels.

Goal 12: Ensure sustainable production and consumption

Target 12.1: Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries

Target 12.2: By 2030, achieve the sustainable management and efficient use of natural resources

Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses

Target 12.5: By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

Target 12.6: Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle

Target 12.7: Promote public procurement practices that are sustainable, in accordance with national policies and priorities

Target 12.8: By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature

Target 12a: Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Target 14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

Target 14.6: By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognising that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation.

Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Target 15.1: By 2020, ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

Annex B

A snap-shot of G7 countries and EU initiatives on resource efficiency

Canada

National policy framework

2009 Canada-wide EPR plan.

2015 Minerals and metals policy.

Resources covered

Materials and natural resources, and their linkages.

Range of activities covered

A range of activities across the lifecycle of products: extraction, production, consumption, disposal.

Targets

No national level target.

Priorities

90 product groups are covered by EPR schemes. The EPR plan commits jurisdictions to implement programmes in the following areas:

- by 2015: packaging; printed materials; mercury-containing lamps; electronics; household hazardous and special waste; automotive products;
- by 2017: construction and demolition waste; furniture; textiles and carpets; appliances; ozone depleting substances.

Main programmes

In addition to the EPR programmes, governments enter into partnerships with business and other stakeholders to promote resource efficiency in different sectors, including through support for R&D and investment. Initiatives have been implemented on green mining, sustainable development technology, pulp and paper, forestry, and oil sands.

France

National policy framework

2015 Energy Transition for Green Growth Act recognised the circular economy as one of five pillars of sustainable development. The transition to a circular economy is one of the core objectives of the Act.

Resources covered

Raw materials including biomass.

Range of activities covered

Various measures adopted to improve resource efficiency along the value chain targeting:

- the design of products, including through extended producer responsibility (EPR) schemes;
- sustainable production;
- sustainable consumption;
- waste management;
- territorial development;
- international (trans-frontier waste).

Targets

By 2030, increase by 30% the ratio of GDP to domestic consumption of raw materials (compared with 2010); and reduce per capita consumption of raw materials nationwide.

By 2020, reduce the volume of non-recyclable manufactured products on the market by 50%.

A range of quantitative targets for waste management were established.

Priorities

Specific measures target waste streams such as food waste and plastics. In addition to those identified in EU directives, EPR schemes apply to other waste streams such as textiles, furniture, graphic paper and medical waste.

A national stakeholder working group recommended the adoption of a resource efficiency strategy focused on a limited number of priority resources.

Several sectors are also prioritised including sustainable building, clean transport, renewable energy and nuclear safety.

Some of the main programmes

A national circular economy strategy is to be prepared every 5 years.

National Council of Industry supports the development of industry sector plans, including innovation and financial support.

Information to consumers.

Green public procurement.

EPR schemes.

71 innovation clusters established to promote public-private co-operation in R&D and training.

Germany

National policy framework

2012 Resource Efficiency Programme (ProgRESS).

2002 National Sustainability Strategy.

2010 Raw Materials Strategy.

Resources covered

ProgRESS covers biotic resources not used for energy production (ores, industrial minerals, construction minerals) and the use of biotic resources as materials. It does not include natural resources such as water, air, land, soil, biodiversity and ecosystems which are covered by other government programmes.

Range of activities covered

ProgRESS aims to cover the entire value chain, from the extraction of resources through to final disposal. International co-operation with emerging and developing countries is an important part of the programme.

Targets

A target was established in the 2002 National Sustainability Strategy to double resource productivity by 2020 using 1994 as a base year. Progress is monitored every 4 years by the National Statistical Office.

Priorities

In addition to those identified in EU directives, EPR schemes apply to other waste streams such as biowaste.

ProgRESS identifies 7 examples of sectors where actions have been taken: bulk metals; rare earths and critical metals; planning, construction and buildings; photovoltaic systems; electromobility; IT; and chemicals.

Four examples of material flows are provided: phosphorous, indium, gold and plastics.

Some of the main programmes

Raw materials strategy.

Support to the manufacturing sector, particularly small- and medium-sized enterprises.

Information to consumers.

Green public procurement.

EPR schemes.

Support for R&D and innovation.

International: trans-frontier waste; transfer of know-how and technology through development co-operation programmes.

Italy

National policy framework

The sustainable development strategy and the national plan for sustainable production and consumption provide the overall policy framework for resource efficiency. The development of a Green Act is under consideration which could provide additional support for resource efficiency.

Resources covered

Energy, water.

Range of activities covered

The main programmes focus on renewable energy and energy efficiency; water management; and waste management, including EPR.

Targets

Several quantitative targets have been set:

- Reduction of Total Material Requirement by 25% by 2010, 75% by 2030 and by 90% by 2050;
- At least 30% of the public purchases to match ecological requirements;
- 30-40% of durable goods with reduced energy consumption.

Priorities

Plastics, construction materials, aggregates.

In addition to those identified in EU directives, EPR schemes apply to other waste streams including agricultural film.

Main programmes

Energy efficiency.

Renewable energy.

EPR schemes.

Green public procurement.

Trans-frontier waste.

Japan

National policy framework

2001 Fundamental law for a sound material-cycle society: this is supported by laws on waste management and efficient use of resources, as well as regulations applying to specific waste streams and resources.

2000 Green purchasing act.

Resources covered

Materials used in the economy.

Range of activities covered

Comprehensive range of activities throughout the product lifecycle. Priority also given to international co-operation, particularly in the Asian region.

Targets (to be achieved by 2015 using 2000 as the base year)

- Resource productivity: 60% improvement; equivalent to JPY 420 000 per ton.
- Cyclical rate (the proportion of the total material input to the economy that remains in productive use): 40-50% increase; equivalent to about 14-15% of the total material input.
- Final disposal volume: 60% reduction; equivalent to 23 million tons.

Priorities

As specified by the Cabinet in the 3rd Fundamental law for a sound material-cycle society: promoting 2Rs (reduce and reuse); recovery and recycling of useful metals; recycled waste and biomass to energy; integration of initiatives for low carbon society, harmony with nature and upgrading local recycling networks; co-operation and technology transfer, particularly in the Asian region; treatment and reuse of waste from the Great East Japan earthquake; safe treatment of radioactive-contaminated waste from the earthquake.

Main programmes

As defined by the main bodies of legislation: containers and packaging; home appliances; construction materials; food waste; end-of-life vehicles; small home appliances; and green purchasing.

United Kingdom

National policy framework

2005 Sustainable Development Strategy identified four priorities including sustainable production and consumption, and natural resources.

2011 government vision on mainstreaming sustainable development.

2012 document, "Enabling the transition to a green economy" and a Resource Security Action Plan.

Resources covered

Renewable and non-renewable resources.

Range of activities covered

All stages along the value chain have been addressed, from resource extraction through production, consumption and final disposal. Provision has been made for international co-operation.

Objectives/targets

No overall national target has been set, but targets have been set for specific waste streams.

Priorities

Food waste, textiles, electrical and electronic equipment.

Main programmes

Resource security action plan.

Programme to promote resource efficiency partnerships (WRAP).

Green procurement.

EPR.

Research and innovation.

Industrial symbiosis (proposal for a G7 initiative).

United States

National policy framework

2002 Beyond RCRA: waste and materials management in 2020.

2009 Sustainable materials management: the road ahead.

2017-22 SMM Strategic Plan.

Resources covered

Main focus on materials used in the economy.

Range of activities covered

Full lifecycle approach.

Objectives/targets

National objective focuses on tracking and reducing the overall amount of materials disposed, which would encompass activities targeting source reduction, reuse, recycling and prevention. National target: by 2030, reduce by 50% food loss and waste in retail and consumer sectors, as well as the amount of food ultimately disposed of in landfill.

Priorities

Sustainable materials management (SMM) seeks most productive use of materials across their lifecycle, minimising amount of materials used and all associated impacts. SMM approaches can potentially fill the gap in the current Intended Nationally Determined Contributions. Using lifecycle analysis, 38 materials, goods and services with significant environmental impacts were identified. These included materials, goods and services from the following sectors: food, textiles, non-renewable organics, metals and construction.

Main programmes

In the 2017-22 period, the main priorities will be: built environment, sustainable food management, and sustainable packaging. Work will also be carried out sustainable electronics management, international co-operation on lifecycle analysis and SMM, and overall measurement efforts.

European Union

National policy framework

Europe 2020 strategy for smart, sustainable and inclusive growth.

7th Environmental Action Plan (2013-20), with the thematic objective to turn the EU into a resource-efficient, low-carbon competitive economy.

2015 EU Action Plan for a Circular Economy presents an ambitious and comprehensive range of initiatives, including legislative changes.

Resources covered

Comprehensive coverage of renewable and non-renewable resources.

Range of activities covered

Comprehensive range of activities throughout the product lifecycle: sourcing, design, production, consumption, "closing the loop," disposal, supporting markets for secondary materials. International activities will be oriented to achieving the resource efficiency components of the SDGs.

Objectives/targets

An overall resource efficiency target has not been established. Several waste targets have been identified:

- a common EU target for recycling 65% of municipal waste by 2030;
- a common EU target for recycling 75% of packaging waste by 2030;
- material-specific targets for different packaging materials;
- a binding target to reduce landfill to 10% by 2030.

Priorities

Plastics (including marine litter); food waste; critical raw materials; construction and demolition materials; biomass and bio-based products.

Main programmes

An ambitious range of programmes covering all stages of the lifecycle and priority resources identified. They will be supported by cross-cutting programmes on innovation, finance and monitoring through indicators.

Annex C

OECD policy guidance on extended producer responsibility

2001 guidance (OECD, 2001)

The 2001 OECD Guidance Manual (OECD, 2001) is more than 150 pages, divided into 8 chapters and with 15 annexes. It includes 6 checklists for policy makers as well as the following set of guiding principles for the design and development of EPR policies and programmes. The main recommendations include:

- EPR policies and programmes should be designed to ***provide producers with incentives*** to incorporate changes upstream at the design phase in order to be more environmentally sound.
- Policies should stimulate ***innovation*** by focusing more on results than on the means of achieving them, thus allowing producers flexibility with regard to implementation.
- Policies should take into consideration a ***lifecycle approach*** so that environmental impacts are not increased or transferred somewhere else in the product chain.
- ***Responsibilities*** should be well defined and not be diluted by the existence of multiple actors across the product chain.
- The ***unique characteristics and properties*** of a product, product category or waste stream should be factored into policy design. Given the diversity of products and their different characteristics, one type of programme or measure is not applicable to all products, product categories or waste streams.
- The ***policy instrument(s)*** selected should be flexible and chosen on a case-by-case basis, rather than setting one policy for all products and waste streams.

- Extension of producer responsibilities for the product's lifecycle should be done in a way to ***increase communication*** between actors across the product chain.
- A ***communication strategy*** should be devised to inform all the actors in the product chain, including consumers, about the programme and to enlist their support and co-operation.
- To enhance a programme's acceptability and effectiveness, a ***consultation of stakeholders*** should be conducted to discuss goals, objectives, costs and benefits.
- ***Local governments*** should be consulted in order to clarify their role and to obtain their advice concerning the programme's operation.
- Both ***voluntary and mandatory approaches*** should be considered with a view on how to best meet national environmental priorities, goals and objectives.
- A ***comprehensive analysis*** of the EPR programme should be made (e.g. which products, product categories and waste streams are appropriate for EPR, whether historical products should be included, and the roles of the actors in the product chain).
- EPR programmes should undergo periodic ***evaluations*** to ensure that they are functioning appropriately and are flexible enough to respond to these evaluations.
- Programmes should be designed and implemented in a way that environmental benefits are obtained while domestic economic ***dislocations*** are avoided.
- The process of developing and implementing EPR policy and programmes should be based on **transparency**.

2015 guidance (OECD, forthcoming a)

On the design and governance of EPRs

- Fully implement the recommendations on the good governance of EPR systems in the 2001 OECD Guidance Document, particularly concerning the need to establish clear objectives, to specify the roles and responsibilities of stakeholders, and to establish platforms for dialogue among stakeholders.
- Periodically review the targets of EPR policies and adjust their ambition in line with waste management and resource productivity

policy objectives; take account of the costs and benefits of proposed targets and establish them in consultation with stakeholders.

- Consider extending the scope of EPRs, particularly to cover more environmentally sensitive end-of-life products which are inappropriate for landfill disposal or incineration.
- In mandatory systems, governments should establish consistent and credible means for enforcing EPR obligations, including registers of producers, accreditation of PROs and appropriate sanctions.
- Governments and industry should co-operate to establish effective, adequately-resourced monitoring systems; in some circumstances, they may consider establishing an independent monitoring body financed by a tax on PROs.
- Mandatory EPR systems should be required to report regularly on the technical and financial aspects of their operations; their performance should be regularly audited, preferably independently; to the extent possible, definitions and reporting modalities for EPR systems operating in the same jurisdiction should be harmonised, and a means for checking the quality and comparability of data established; voluntary EPR systems should be encouraged to be as transparent as possible and periodically to undergo independent evaluations of their operations.
- The sharing of experience among EPRs, nationally and internationally, should be encouraged with a view to improving collection and recycling rates, disseminating information on eco-design, and enhancing the cost-effectiveness of EPR systems.

On financing, free-riding and orphan products

- In mandatory systems, governments should establish consistent and credible means for enforcing EPR obligations, including registers of producers, accreditation of PROs and appropriate sanctions.
- Governments and industry should co-operate to establish effective, adequately-resourced monitoring systems; in some circumstances, they may consider establishing an independent monitoring body financed by a tax on PROs.
- The cost of end-of-life treatment ideally should be internalised into the price of the product and paid for by consumers; Producers should be responsible for financing the end-of-life costs of their products;

- Free-riding should be addressed through peer pressure and strict enforcement with suitable sanctions.
- Orphan products should be addressed by opting for an approach that is adapted to the specific nature of the challenge involved, including: current producers covering their own costs as well as those of former producers; ADF; fees paid at purchase; last owner pays; and insurance;
- Governments should exchange experience on, and identify ways in which EPR systems can be financed in a sustainable manner; this should include analysis of how risks such as price volatility, leakage,etc. could be managed.

To further promote the integration of competition policy and EPRs

- Competition impact assessments should be integrated into the design of EPR policies, taking account of the 2009 OECD Council Recommendation on Competition Assessment (2009), and the 2005 Council Recommendation on Regulatory Policy and Governance.
- Competition authorities periodically should issue easily-accessible guidance or information regarding their consideration of EPRs.
- Agreements to establish a PRO should be assessed by competition authorities within the jurisdiction's general framework for assessing horizontal agreements. Contracts between service providers and PROs should be assessed on a case-by-case basis within the jurisdictions general framework for assessing vertical agreements.
- Competition authorities should not distinguish between voluntary and government-sponsored agreements.
- EPR schemes should allow single PROs only when it can be demonstrated that the benefits (for example the capacity to manage the waste would not otherwise be built) outweigh the costs of less competition; the operations of monopoly PROs should be kept under review and competition encouraged when the benefits of single PROs no longer outweigh their costs.
- Any restrictions on competition intended to support the introduction of the EPR (such as allowing a PRO exclusive rights to a market) should be phased out as soon as possible.
- Services such as waste collection, sorting, and treatment, should be procured by transparent, non-discriminatory and competitive tenders. Factors that should be taken into account in this regard include providing for sufficient but not excessive contract duration, sufficient

scale to provide incentives for investment, and sufficient scale and level of aggregation to facilitate bidding by all qualified firms.

- Tenders should not oblige collectors and recyclers to contract exclusively with one PRO. Other possible distortions, such as those that may result from bundling collection together with sorting and processing, should also be assessed.
- Post-consumer materials should not be allocated in a way that raises barriers to entry or expansion in the product market; for example when material is allocated at below market prices according to historical product market share.
- PROs, national registers or other clearinghouses should be designed so as to prevent the sharing of confidential market information that could result in anti-competitive behaviour.

On incentives for design for environment

- Ensure the full costs of end-of-life management are covered by producer fees in order to maximise design-for-environment incentives.
- Variable rather than fixed producer fees should be applied in collective schemes where this is feasible.
- Consider the use of innovative approaches such as modulated fees (e.g. according to content of hazardous substances) or the use of new technology that may allow to link fees with end-of-life costs for specific products and improve cost allocation among producers;
- Enhance information flows from downstream sectors and users to manufacturers with a view to enhancing design for environment.
- PROs should support R&D efforts intended to improve the eco-design of their products by sharing their experience and, when cost-effective, by providing financial support.
- International harmonisation of the design of globally-traded products should be encouraged with a view to improving their eco-design.

For integrating informal workers in EPRs in emerging and developing economies

- The role that informal recyclers play should be recognised: in many emerging economies, they are responsible for most of the materials that are captured, processed and sold in the recycling value chain.

- Cities in emerging economies should consider how they could best draw on the knowledge of waste pickers and junk shops; they are often the only stakeholders with practical experience, knowledge to maximise recycling under local market conditions, and incentive to adapt quickly to new value chains and market opportunities.
- Informal recyclers should be invited to contribute their experience and expertise in all relevant public decision making processes. They should be engaged in the design, monitoring and evaluation of recycling and valorisation systems, as well as the definition of quality standards.
- Producers, city authorities and informal recyclers should work together (experiment) to strengthen, or introduce, upstream separation of recyclables, organics and residuals at the level of businesses and households. Upstream separation provides important support for EPR systems. Downstream activities such as dismantling and recycling are potentially more problematic and authorities need to enforce environmental standards in such operations.
- Public authorities should work with informal recyclers to collect data on waste generation and recycling rates. It should not be assumed that no recycling is taking place.
- The insights and ambitions of informal recyclers should be combined with international good practice approaches for integrating informal workers into formal waste management systems, and take full account of relevant health and safety, social protection and financial considerations.
- EPR systems in emerging economies should avoid becoming involved in the recycling of materials where private value chains are likely to work well. EPR systems provide more opportunities for stakeholders, including informal recyclers, when they address market failures, including: environmentally sensitive waste streams, low-value materials, recyclables difficult to dismantle, or recycling in areas where there are few value chain buyers within reasonable transport distance.
- Priority should be given to developing business partnerships with informal, and micro and small, recycling enterprises over Public Private Partnership approaches government more than the host community.
- In developing EPRs, engage local authorities, municipal associations, national governments, regional economic communities, and bilateral and multi-lateral institutions; evaluate, disseminate, and use good practices of partnerships involving informal recyclers to inform public policy and legislation; and use these partnerships and activities to promote recognition of the informal recycling sector.

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Policy Guidance on Resource Efficiency

This report responds to the request by G7 Leaders at the Schloss Elmau Summit in June 2015, for the OECD to develop policy guidance on resource efficiency. Establishing a resource efficient economy is a major environmental, development and macroeconomic challenge today. Improving resource efficiency by putting in place policies that implement the principles of reduce, reuse, recycle (the 3Rs) is crucial to improving resource use, security and competitiveness while diminishing the associated environmental impacts.

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