# Synergies and trade-offs in the transition to a Resource-Efficient and Circular Economy

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# Synergies and trade-offs in the transition to a Resource-Efficient and Circular Economy

## Disclaimers



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Authorised for publication by Jo Tyndall, Director, Environment Directorate.

# Acknowledgements

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This report synthesises insights from a range of OECD reports on the transition to a resource-efficient, circular economy as part of the OECD "Resource Efficiency and Circular Economy" (RE-CIRCLE) project. The RE-CIRCLE project (oe.cd/recircle) is co-ordinated by Rob Dellink and Peter Börkey, while Elisa Lanzi (OECD Environment Directorate) oversees the modelling. The project provides policy guidance on resource efficiency and the transition to a circular economy. It aims to identify and quantify the impact of resource-efficient, circular economy policies to guide a range of stakeholders in OECD member countries and emerging market economies through quantitative and qualitative analysis. The RE-CIRCLE project is structured around two complementary work packages toward sound evidence-based policy recommendations. The first workstream uses qualitative analysis on selected topics to guide policies to further the transition to the circular economy. The second workstream uses global environment-economy modelling to project the impacts of resource use and the effect of policy interventions. This Policy Paper focuses on synergies and trade-offs that can be found among different policy instruments by exploiting the complementary nature of the two work packages of the RE-CIRCLE project.

Many OECD Environment Directorate colleagues contributed to the RE-CIRCLE project, including Eva Barteková, Ruben Bibas, Peer Börkey, Andrew Brown, Elena Buzzi, Jean Chateau, Elisabetta Cornago, Rob Dellink, Maarten Dubois, Matthias Helf, Elisa Lanzi, Frithjof Laubinger, Linda Livingstone, Eleonora Mavroeidi, Andrew McCarthy, Nestor Pelecha Aigues and Shunta Yamaguchi. Ijeoma Inyama Dalles, Katjusha Boffa, Illias Mousse Iye, Aziza Perrière and Emily Seftel (all OECD Environment Directorate) provided administrative support.

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# Executive Summary

In the last century, an unprecedented increase in natural resources and materials use has occurred in our societies and as the global economy expands and living standards rise, the world's raw materials consumption is expected to further grow and nearly double by 2060. This is particularly alarming because materials extraction, processing, use and waste management lead to significant environmental pressures, ranging from local pollution at mining sites to greenhouse gas emissions from metal processing to air pollution from waste handling. By 2060, greenhouse gas emissions related to materials management will be twice as high as current levels, putting severe pressures on the world's climate system.

The business-as-usual is unsustainable, and these trends need to be reversed. Concrete actions across the entire value chain are required to address environmental challenges related to materials extraction, processing, use and waste management. The transition towards a resource-efficient, circular economy offers an opportunity to help achieve material security while improving environmental and economic outcomes. The reduction in environmental impacts linked to material resource production and use depends on both the level of ambition of national policies and the degree of international engagement and co-operation.

This policy paper highlights the synergies that policy makers can create between different objectives of the Resource-Efficient and Circular Economy (RE-CE) transition, but also the trade-offs that need to be considered when designing balanced policy packages. The synergies and trade-offs discussed in this paper are structured around the following four objectives of the RE-CE transition: (i) reduce primary production and increase resource efficiency; (ii) create and strengthen markets for secondary products; (iii) prevent and manage waste to minimise associated environmental impacts; and (iv) build economic resilience and lessen the exposure to geopolitical supply risks. Synergies with other environmental policies should be exploited. Furthermore, international co-ordination and alignment with adjacent policy domains, not least international trade, is crucial.

First, rolling out certain policy mixes can create desirable synergies between the RE-CE's economic, environmental and social objectives. Reducing the environmental impacts associated with primary material production and use is one of the key ambitions of the RE-CE transition. By making primary materials production more expensive, the use of these materials is disincentivised, and more efficient use of materials is encouraged. At face value, this may have negative consequences on economic goals. Yet, it may boost economic efficiency and welfare by inducing more efficient resource use and reducing environmental externalities associated with global extraction and materials processing. Economic growth is especially boosted when induced innovation effects spur an increase in overall productivity and, thus, faster economic growth.

Second, unlike the current linear economy, in which goods are manufactured from virgin materials, sold, used, and discarded as waste, a resource-efficient and circular economy uses waste as a resource and strives to maximise the use of products in the context of continuously evolving consumer needs. Expanding recycling, re-use and repair networks, as well as increasing the share of secondary materials in production, constitute the basis for the RE-CE transition. In pursuing this goal, policy makers can achieve synergies between environmental, economic and social goals, such as diminishing environmental impacts linked to materials (recycled materials usually have smaller environmental footprints than virgin materials), and creating new jobs in recycling, repair and refurbishment of end-of-life products. Achieving these goals necessitates the implementation of coherent policies that lead to proper incentive mechanisms, as well as the existence of well-functioning markets for secondary materials and for product reuse and repair.

Third, addressing the environmental impacts associated with waste management is a key objective that can be stimulated by a carefully designed RE-CE policy package that exploits complementarities between policies influencing the different stages of the materials' life cycle. The waste hierarchy concept can be a useful guide for waste management policy. By aligning waste management policies and underlying incentive mechanisms with the waste hierarchy, policy makers can reduce end-of-life emissions and realise synergies with the economic goals of the RE-CE transition.

Fourth, the global economy currently relies extensively on non-renewable raw materials of which many tend to be clustered geographically. The exhaustion of economically competitive mineral deposits in industrialised countries has made supplies increasingly dependent on the political stability of a few mineral-rich countries. This becomes problematic when there is low substitutability in current applications and low recycling rates, which is the case for many rare metals and minerals extensively used in modern technology. Policymakers can address these issues by developing strong domestic recycling and secondary materials sectors and create another important set of synergies related to material security.

Fifth, a transition to a resource-efficient and circular economy can complement and create synergies with other environmental policy issues and thus reduce overall economic and welfare costs that they induce. By deepening the understanding of the interconnectedness between different policy domains, such as material resource use and climate change, policy makers can ensure better policy alignment and accomplish numerous goals simultaneously while avoiding possible trade-offs.

Finally, global commitment and international co-operation underpin the effectiveness of policies aiming to improve resource efficiency and decrease the environmental impacts of resources used. Given that the current economy is characterised by complex global value chains, there is a strong need for intensified international co-operation to build sustainable supply chains that align with the RE-CE goals. Moreover, policy action at the international level can help alleviate barriers to trade that are responsible for limiting the distribution of the best available environmental technologies and reducing the scope and scale of resource efficiency improvements. Globally coordinated RE-CE policies would amplify their positive outcomes.

# 1 Significance of the Resource-Efficient and Circular Economy transition

Rising populations and increasing income levels have led to significant global growth in the use of primary materials. Without additional policy action, global materials use is projected to almost double from 2017 to 2060 despite projected productivity improvements and the declining share of material-intensive sectors in the economy of both developed and developing countries (OECD, 2019[1]). Increases in material use will also entail significant impacts on the environment (Box 1.1). In this context, a transition to a more resource-efficient and circular economy has attracted increased attention from governments and policy makers across the globe. It offers a compelling response to the challenge of reducing the environmental impacts associated with materials use while supporting further improvements in standards of living (McCarthy, Dellink and Bibas, 2018[2]).

A sizeable number of international frameworks and strategies which lay down the path for a transition to a more resource-efficient and circular economy (RE-CE) have emerged since the 2000s. Notably, the G8 Environment Ministers signed the Kobe 3R Action Plan in 2008, which instituted the "3Rs" paradigm (Reduce, Reuse and Recycle). Similarly, the *OECD Recommendation of the Council on Resource Productivity* aims to encourage sustainable resource management and limit environmental impacts associated with the use of resources (OECD, 2008[3]). The G7 Alliance on Resource Efficiency, established in 2015, laid the foundations for the adoption of the Toyama Framework on Material Cycles and the 5-year Bologna Roadmap. More recently, in 2017, the G20 Resource Efficiency Dialogue was established. In 2019, the European Commission released the European Green Deal, which provides an action plan to increase resource efficiency in order to move to a more circular economy, restore biodiversity and cut pollution in EU Member States (EC, 2019[4]). The Commission has since worked on specific policy developments to put the Deal into action (EC, 2021[5]). Moreover, a large number of OECD countries developed a variety of action plans, roadmaps and platforms to steer their economies towards more resource-efficient and low-carbon trajectories (Börkey, Linster and Laubinger, 2021[6]).

Circularity of the economy is a means rather than a goal. There is no unique definition of a Resource-Efficient and Circular Economy and governments place different priorities on the goals that transitioning to a RE-CE can achieve: some emphasise the effects of the RE-CE transition as a means to reducing environmental pressures, others highlight the opportunities to create jobs and economic growth, and fulfil other social objectives. In this policy paper, the circular economy transition is interpreted broadly and includes aspects of circularity as well as resource efficiency and sustainable waste management, and recognises its environmental, social and economic objectives.

This policy paper highlights the synergies that policy makers can create between different objectives of the RE-CE transition when they design balanced policy packages. For instance, using the revenues from material taxes can be used to lower labour taxes and thus contribute to social outcomes. It also highlights potential trade-offs that may arise when implementing RE-CE policies. For instance, taxing primary production to disincentivise primary material use contributes to reducing associated environmental impacts but may have negative economic consequences in material intensive sectors. The synergies and trade-offs are structured around the following four objectives of the RE-CE transition (OECD, 2020[7]):

(I) Reduce primary production and increase resource efficiency
(II) Create and strengthen markets for secondary products
(III) Manage waste to minimise associated environmental impacts
(IV) Build economic resilience and lessen the exposure to geopolitical supply risks.

The remainder of this policy paper is structured as follows. Section 2 lays out these objectives and places them in the context of different national priorities and the United Nation's Sustainable Development Goals and continues with an overview of the policy instruments that can support the RE-CE transition, with a focus on economic instruments. Section 3 discusses the various synergies and trade-offs across RE-CE instruments in detail. Section 4 addresses interactions with other policy domains, such as the post Covid-19 green recovery and the low-carbon energy transition. Section 5 discusses the need for international policy coordination and cooperation, which is essential to ensure an effective RE-CE transition. Finally, Section 7 concludes the paper with final remarks.

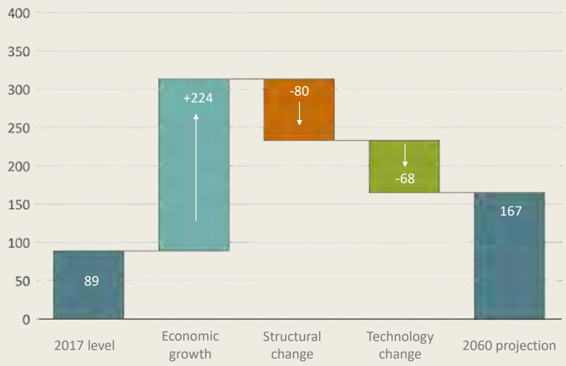
## Box 1.1. Trends in materials use and associated environmental impacts.

Global population is projected to reach more than 10 billion people by 2060. Whilst structural and technological changes in the economy lead to resource productivity improvements and some decoupling of materials use from economic growth, population growth coupled with rising global affluence is still projected to lead to a near doubling of global materials use from 89 gigatonnes (Gt) in 2017 to 167 Gt in 2060 (Figure 1.1); see (OECD, 2019[1]).

This projected increase in materials use is also projected to lead to increased environmental impacts. These environmental impacts include emissions of fine particulate matter (PM2.5), carbon monoxide (CO) and carbon dioxide ($CO_2$) in the air, water and/or soil, as well as the energy and land footprints. Lifecycle environmental consequences of primary production differ significantly depending on the type of material that is produced (Figure 1.2). A large share of total emissions attributed to materials use is released during the combustion of fossil fuels, especially coal, that underlie the production processes. Importantly, the *OECD Global Material Resources Outlook to 2060* highlights that the use of secondary materials can significantly lower environmental impacts compared to the production and use of primary materials (OECD, 2019[1]).

### Figure 1.1. Growth in materials use between 2017 and 2060

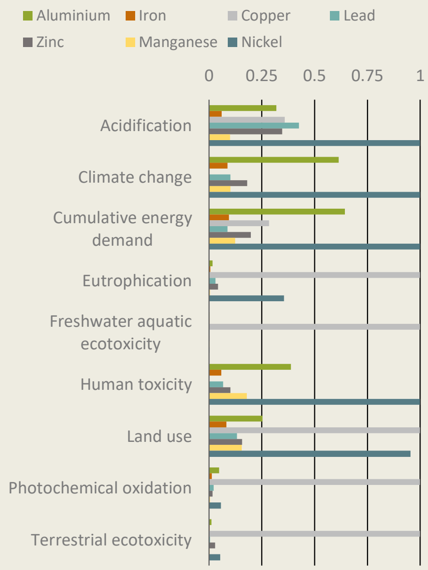
In Gt




Source: (OECD, 2019[1]).

### Figure 1.2. Per kg impact of primary metal production

Normalised index value of different environmental impacts for 2015




Note: for each environmental indicator, the metal whose production has the largest impact gets a value of 1.

# 2 Objectives and policy instruments for the RE-CE transition

## The RE-CE transition contributes to policy ambitions across multiple domains

National strategies tackling the RE-CE transition often lay out a set of goals, which can be categorised into three broad spheres: economic, environmental, and social spheres. The categorisation chosen below is purely indicative, as some goals can belong to more than one sphere, i.e. labour market goals can both belong to the economic and social spheres.

**Economic sphere**: An essential economic goal of the transition is to achieve decoupling between economic growth and materials use, which can unfold through three main channels: technological change (efficiency improvements); innovation, including introduction of more durable goods; and substitution of materials by steering towards more environmentally friendly options. All of these can improve material productivity and help slow resource loops (McCarthy, Dellink and Bibas, 2018[2]). Furthermore, for importing countries, the transition is perceived as a way to strengthen economic resilience because it can reduce import dependency. At the same time, by addressing resource efficiency and the amount of waste, circular business models aim to increase the competitiveness of domestic firms. Another important economic aspect of the transition is to create business opportunities and boost the sharing economy, which can result from changes in production modes.

**Environmental sphere**: Environmental goals of the transition are primarily directed at reducing the environmental footprint of material production and consumption, which can be achieved in numerous ways. Essentially, a RE-CE transition can reduce the pressure on virgin material extraction and help in managing natural resources efficiently. Another important goal that goes with that ambition is to increase the share of secondary materials in the economy, since their environmental impact is estimated to be, on average, lower by one order of magnitude than those of primary materials for an equal weight (OECD, 2019[1]).

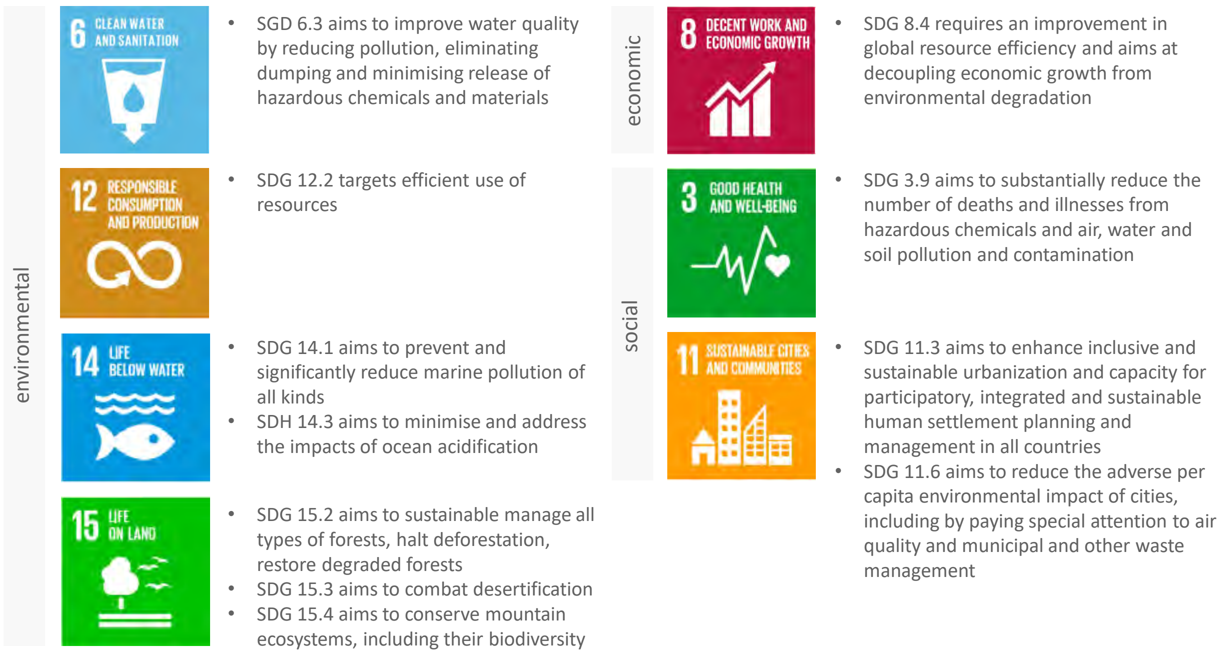
**Social sphere**: Social goals of an RE-CE transition include increasing employment opportunities (for example through the development of circular business models), increasing general welfare (for example by ensuring higher disposable income from increased economic growth), improving public health through reduced exposure to hazardous substances and use of materials that are less harmful to human health, and more generally, sustaining improvements in living standards through a better quality of the environment and resource sufficiency (Laubinger, Lanzi and Chateau, 2020[9]; McCarthy, Dellink and Bibas, 2018[2]). Another essential aspect is expanding the sharing economy, which provides new, innovative ways to satisfy demand for goods and services. New circular business models which promote sharing, rather than owning, have the potential to reduce resource use, and allow individuals access to services at a potentially lower cost (OECD, 2019[10]).

## Priority areas of national RE-CE strategies differ across countries

National strategies and roadmaps developed to address elements of the RE-CE transition often differ in their priority areas. For example, one country's strategy may put an emphasis on promoting innovation for more durable goods, on technological change to increase materials use efficiency and exploit secondary raw materials (focusing on the economic and environmental spheres), while another country might prioritise creating small businesses, engaging all stakeholders and incentivising sustainable production (focusing on the economic and social spheres). Depending on the context in which they are developed, RE-CE strategies can also focus on certain waste streams, stages of the value chain or sectors. For instance, a growing concern about marine plastic litter and its environmental impact has led to the development of national strategies focused on reducing the impact and amount of plastics used in the economy, through enhanced resource productivity and recovery (Börkey, Linster and Laubinger, 2021[6]).

Moreover, countries pursuing objectives of the RE-CE transition can fulfil many of the 17 sustainable development goals (SDG) developed by the United Nations (Figure 2.2). Pursuing certain SDGs, however, may also result in trade-offs with other objectives of the RE-CE transition. For example, pursuing economic growth may slow progress towards achieving environmental goals in certain contexts.

### Figure 2.1. Examples of Sustainable Development Goals (SDG) alignment with the goals of the RE-CE Transition




Source: Own elaboration.

## A range of policy instruments is available

To promote the transition to a more resource-efficient and circular economy, policy makers can rely on a large toolkit of policy instruments.

**Information-based instruments** include public information, consumer education and awareness-raising campaigns, primarily intended to induce behavioural change from customers and producers. For instance, environmental labelling and information schemes support firm-level efforts to improve resource efficiency across value chains and steer consumer purchases towards more environmentally friendly products (OECD, 2020[11]). This group of instruments can create a favourable environment for change but need to be accompanied by regulatory and economic instruments to provide the right incentive structure for transitioning to a more resource-efficient and circular economy.

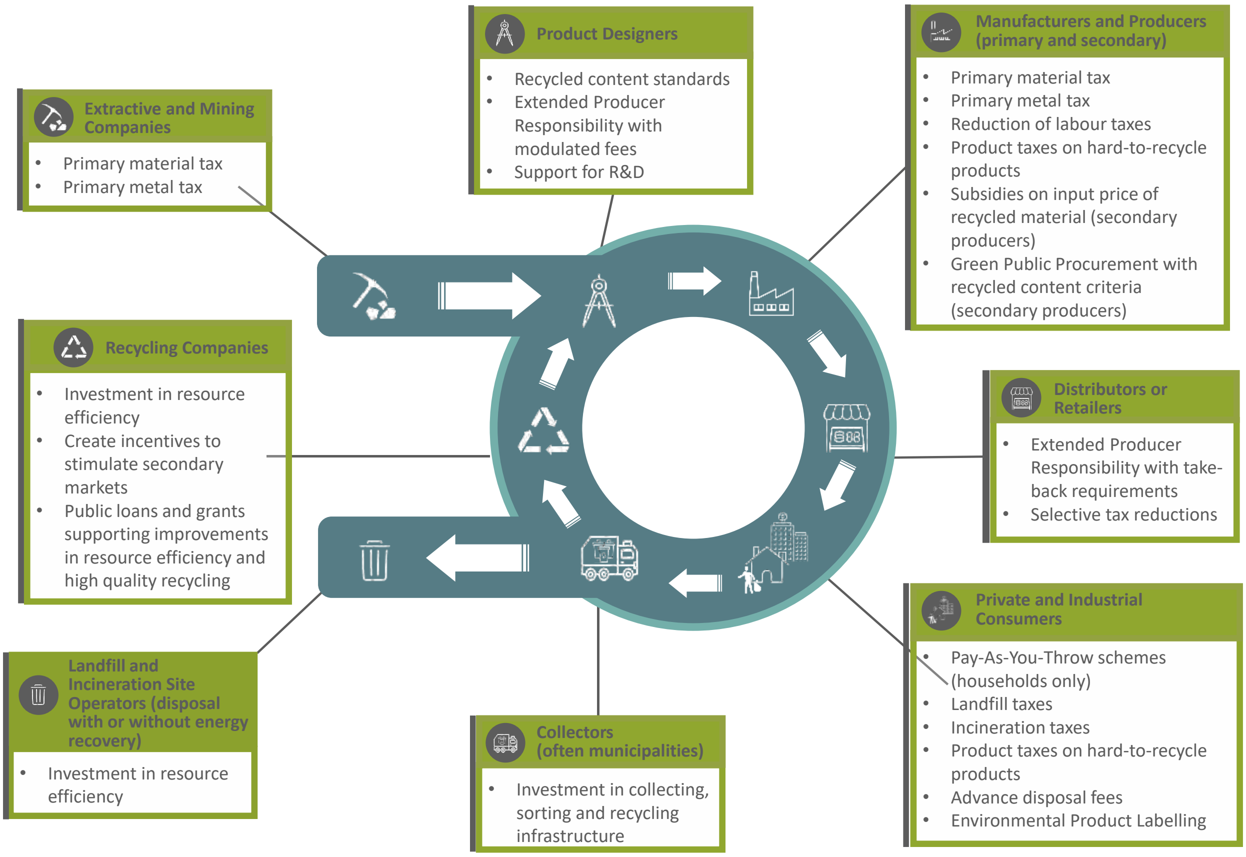
**Economic instruments** (or market-based instruments) that can incentivise the RE-CE transition include taxes, subsidies, and tradable permit schemes (OECD, 2020[11]). For instance, a virgin material tax reduces the environmental impact of resource extraction by increasing the cost of extracting virgin materials, while at the same time incentivising material recovery and recycling. A landfill tax aims at internalising the external costs of landfilling, thereby encouraging other methods of waste management, such as incineration with energy recovery or recycling. Environmentally-motivated subsidies can encourage the development of secondary production and stimulate material productivity. Economic instruments can also address other market failures, such as the volatility of certain markets for recycled products due to restricted access to financial flows from capital markets (McCarthy and Börkey, 2018[12]). Finally, some policies, such as Green Public Procurement (GPP), carry political value because governments applying this measure can pave the way for greater adoption of RE-CE principles and hence set an example for numerous industries.

**Regulatory instruments** include recycling targets, take-back mandates, product standards, eco-design mandates, labelling requirements, recycled-content requirements, lifetime warranties, bans and restrictions. For instance, strict regulations governing the trade in hazardous waste can prevent the risk of environmental leakage with these wastes being exported for non-recovery purposes. Recycled content requirements can boost secondary markets by creating a demand that may not arise from a pure cost perspective. Depending on their design and implementation, some regulatory instruments can operate similarly to economic instruments. This is, for example, the case when regulations allow economic actors to choose the most cost-effective way to achieve regulatory compliance (OECD, 2020[11]; Laubinger et al., 2021[13]).

The taxonomy of instruments presented above is, of course, not perfect, and the labels are not always mutually exclusive. For instance, EPR schemes, which aim at making producers responsible for the end-of-life costs associated with their products, often include elements both regulatory and market-based instruments. The most common instruments employed by EPR schemes often combine take-back requirements with advance disposal fees (OECD, 2016[14]).

Implementing these policy instruments will have different impacts on economic agents depending on where they are situated in the value chain of materials. Figure 2.2 shows the primary point of incidence of the most important instruments.

Figure 2.2. Range of instruments that can promote the transition to a resource efficient and circular economy, organised by their incidence on the economic agent




Source: Own elaboration.

# 3 RE-CE policies create synergies but can also carry trade-offs

Rolling out certain policy mixes can create desirable synergies between the economic, environmental and social objectives pursued by a Resource-Efficient and Circular Economy. This section discusses how policy makers can combine economic instruments to achieve different, yet interwoven, objectives that can lead to the creation of such synergies. At the same time, the implementation of certain RE-CE policies often entails trade-offs with other objectives. Economic growth, equity issues between countries, sectors and workers and environmental considerations need to be carefully balanced when pursuing policy changes. These synergies and trade-offs are grouped into four main objectives of the RE-CE transition.

## Objective 1: Reducing primary material extraction and increasing resource efficiency

Reducing the environmental impacts associated with primary material production and use is one of the key ambitions of the RE-CE transition. By making primary materials production more expensive, the use of these materials is disincentivised and more efficient use of materials is encouraged. At face value, this may have negative consequences on economic goals, but by inducing more efficient resource use and reducing environmental externalities associated with global extraction and materials processing, it may boost economic efficiency and welfare. Economic growth is especially boosted when induced innovation effects spur an increase in overall productivity and, thus, faster economic growth (McCarthy, Dellink and Bibas, 2018[2]). Reducing the use of primary materials can also improve public health by decreasing the amount of toxic emissions released into the air during mining and production. An improvement in public health, in turn, produces desirable economic outcomes, as it can improve labour productivity, reduce health expenditures and thus increase the demand for other goods and services, as well as decrease welfare costs related to premature deaths (OECD, 2016[15]). Policy makers can rely on numerous RE-CE policies to produce these synergies, such as a tax on primary materials use and subsidies supporting the growth of the secondary materials sector, whose effects are discussed next.

### *Macro-economic and environmental effects associated with a reduction in materials use*

A tax on primary materials is an important economic instrument which will disincentivises primary materials use by pricing in environmental externalities and ultimately making primary production more expensive. Bibas, Chateau and Lanzi (2021[16]) find that in a scenario in which a material tax would be rolled out in all countries, it could be possible to reduce the volume of metals by 26% and non-metallic minerals by 8.5% in 2040, compared to the projected business-as-usual scenario. As a result, there are significant improvements in a wide range of environmental indicators, which include lowering greenhouse gas emissions (GHG), water and air pollution, resulting in only a limited loss for global GDP (-0.4%).

One obvious key advantage of levying taxes is that they raise revenues. The revenue generated from such taxes can help mitigate the negative macroeconomic shock induced by taxes, but can also pursue different RE-CE goals, depending on the country's policy priorities. For example, if one of the major goals of the

RE-CE transition is to develop the secondary and recycling sectors, tax revenues can be redistributed in the form of recycling subsidies, such as subsidies on the input price of feedstock for recycling processes or on the selling price of recycled commodities. This improves the profitability of firms participating in the secondary sector, which, in turn, boosts their output. Subsidies can also enable firms to increase their spending on Research and Development (R&D), thus strengthening their future production capacity and business operations. As with primary material taxes, recycling subsidies change relative costs between using secondary and primary materials, making secondary materials cheaper. The indirect effect is that they incentivise firms that rely to a large extent on primary materials to switch to secondary inputs.

### *Uneven economic consequences and loss in competitiveness following a primary material tax*

Despite the limited overall losses it induces on global GDP and its strong environmental benefits, a primary material tax can induce uneven negative economic consequences between countries. In the scenario presented above, Bibas et al. (2021[16]) find that when introducing a global primary material tax the economy of OECD countries will experience a slight decrease (0.1%) in 2040 compared to the baseline scenario, while the economy of the BRIICS and the group of developing countries could witness a 0.7% and 0.4% decrease, respectively. The differentiated impact is explained by the fact that non-OECD countries are characterised by higher material intensity and by processes that rely extensively on primary materials. Obviously, this global implementation of a primary material tax is highly stylised, but can serve as a cost-effective reference point for assessing more detailed policies. Most notably, some economies have fairly narrow production specialisation in commodities that are materials-intensive, and such economies are likely to undergo a more costly transition.

In countries in which the extractive sector represents a large share of the total economy, the transition threatens these sectors. Resource-rich and material-intensive economies may therefore need to develop flanking policies to accommodate the disruption of extractive sectors. This can include a deep structural change, in terms of infrastructure and labour force, to achieve a shift from relying on extractive sectors to other sources of economic growth and employment, and implementation of necessary enabling policies (Yamaguchi, 2021[17]). Material taxes also affect global trade patterns. Since they increase primary production costs, they induce a shift in the comparative advantage of the directly affected production sectors (i.e. mining, materials processing and recycling), with a net effect where the production becomes more geographically concentrated and where trade volumes of materials-related commodities increase. This consequently provokes a relative change in the competitiveness between countries, i.e. while exports of goods and services increase for some countries, they decrease for others (Dellink, 2020[18]). For instance, the modelling suggests that upon implementation of a primary material tax, global exports of copper and other non-ferrous metals remain roughly in line with the baseline projection, but this hides significant re-allocation of exports towards OECD Europe and South and South-East Asia, away from the other regions, mostly in Latin America. This shift causes a macroeconomic cost in the latter economies.

### *Global labour market consequences of RE-CE policies*

A budget-neutral policy package combining material taxes with subsidies to the recycling and secondary markets can considerably boost employment in these sectors. In the same budget-neutral scenario as presented in Bibas et al. (2021[16]), Chateau and Mavroeidi (2020[19]) find that global employment in secondary-based metal production and recycling sectors will respectively be 27% and 46% higher than in the business-as-usual scenario in 2040. Related sectors, such as those which produce substitutes for primary material-based products, could also reach a higher level of employment. Because some sectors will experience job destruction due to primary material taxes, the overall effect on employment is found to be only slightly positive (0.03%) on a global scale (Chateau and Mavroeidi, 2020[19]). Moreover, RE-CE policies will have asymmetric effects on different regions. Certain regions with large extraction sectors can record more job destruction than creation. In particular, employment is projected to be 0.01% lower in Indonesia, and 0.02% lower in Australia and New Zealand in 2040 following the implementation of the package (Chateau and Mavroeidi, 2020[19]).

Primary material tax revenues can also be redistributed to reduce distortionary labour taxes in a budget-neutral way in the context of an environmental tax reform. Although encouraging the RE-CE transition is often not the primary goal pursued when reducing labour taxes, such a policy package can result in beneficial outcomes. First, it is likely to enhance the positive effect on employment to a greater extent than the policy package with recycling subsidies (Laubinger, Lanzi and Chateau, 2020[9]). Indeed, following the decrease of gross-of-tax wage rates, labour demand is stimulated, resulting in a positive impact on total employment, which in turn reduces the (limited) GDP losses incurred from primary material taxes; simultaneously, the higher net-of-tax wages increase, which may stimulate labour supply (and contribute to social objectives). Second, as secondary metal production tends to be more labour-intensive than primary production, reducing labour taxes is another measure that can give a cost advantage to secondary metal production.

### *Uneven labour consequences on sectors and workers*

Like any structural change in the economy, the RE-CE transition entails differentiated impacts on industries and workers. Strong job creation is predicted for secondary-based metal production, services and the recycling sector, while large job destruction can be expected in primary materials extraction (mining) and materials-intensive sectors, including the construction and equipment sectors, due to higher production costs (Chateau and Mavroeidi, 2020[19]). This is why employment in countries with large extractive sectors is more affected by primary material taxes than in more service-oriented countries. They can, however, alleviate negative employment effects by introducing recycling subsidies or reducing labour taxes, as discussed previously (Chateau and Mavroeidi, 2020[19]; Bibas, Chateau and Lanzi, 2021[16]).

Moreover, the RE-CE transition will create both high and low-skilled jobs (EU, 2017[20]). However, it will also induce a lower demand for certain skill levels, especially medium and low skills (Chateau and Mavroeidi, 2020[19]). To ensure a smooth job transition between the affected sectors, appropriate measures, such as re-training programmes for the workforce, should be implemented. New labour market opportunities are expected to mostly require a "top-up" of existing skills rather than fundamentally new skills (Cedefop, 2010[21]), which can be addressed through flanking education and labour policies (Laubinger, Lanzi and Chateau, 2020[9]).

Furthermore, potential equity issues should be considered in the context of an environmental tax reform. While employment can be stimulated by lower labour taxes, the latter may exacerbate differences in income distribution between high and low-skilled workers. Given that low-skilled workers tend to earn less, and that labour taxes tend to be progressive (i.e. higher wages imply higher average tax rates), they are left out from most of the benefit of (undifferentiated) wage tax cuts and would rather benefit from a lump-sum transfer. At the same time, however, the lump-sum transfer stimulates to a lesser extent total employment (Chateau, Bibas and Lanzi, 2018[22]; Bibas, Chateau and Lanzi, 2021[16]). A solution could be to target labour tax reductions more specifically at low-skilled workers.

### *Unintended environmental consequences of the RE-CE transition*

One final observation should be made regarding the environmental outcomes of RE-CE policies. While RE-CE policies are generally beneficial to the environment (secondary materials tend to be less harmful than primary materials), this might not always be true. In some instances, the environmental benefits associated with the reduction in primary production may be offset by the negative effects of increased secondary production. This can be the case if the primary production takes place in a stringently regulated and highly efficient facility, and less efficient secondary production takes place in a laxer environmental policy environment, such as is often the case in developing countries. Additionally, more circular business models have the potential to significantly reduce environmental pressure resulting from economic activity, but there is still a risk that they create activities with a large environmental footprint. For instance, an increase in the production of bio-based materials may come at the expense of forests when these are converted into agricultural land to provide feedstock (OECD, 2022[23]). The evolution of these emissions and pollutants, as well as their location, need to be considered carefully by policy makers when implementing RE-CE policies.

## Objective 2: Strengthening markets for secondary materials and promoting materials circularity

Unlike the current linear economy, in which goods are manufactured from virgin materials, sold, used, and discarded as waste, a resource-efficient and circular economy uses waste and end-of-life products as a resource and strives to maximise the use of products in the context of continuously evolving consumer needs. Expanding recycling, re-use and repair networks as well as increasing the share of secondary materials in production constitute the basis for the RE-CE transition (OECD, 2020[7]). In pursuing that, policy makers can achieve synergies between environmental, economic and social goals. Achieving these goals necessitates the implementation of coherent policies that lead to proper incentive mechanisms, as well as the existence of well-functioning markets for secondary materials.

### *Promoting materials circularity improves environmental indicators*

Focusing on the upstream processes of a resource-efficient and circular economy – re-use, repair, remanufacturing – is essential to slowing the introduction of new natural resources into the economy and preventing waste (McCarthy, Dellink and Bibas, 2018[2]). A number of environmental impacts can be avoided in this way (see Figure 1.2 in Box 1.1 and Objective III). Recycling also plays a key role in the transition, as secondary materials use has a much smaller average environmental footprint than primary materials use. For instance, land use requirements, cumulative energy demand, as well as soil, water, and air pollution are much lower on average for secondary materials production than primary materials production (OECD, 2019[1]). Increasing the share of secondary materials in production can especially reduce emissions of $CO_2$-eq., carbon monoxide (CO), sulphur dioxide ($SO_2$) and fine particulate matter (PM2.5). This effect is more pronounced in countries that realise a large reduction in materials intensity and significantly reduce the share of primary resources in their processes, though it is not possible to draw robust conclusions on the effects for specific producers in different countries (Bibas, Chateau and Lanzi, 2021[16]). However, as pointed out in Objective I, there is a risk that the reduction in certain emissions associated with reduced primary metal production are offset by an increase in these emissions related to secondary metals production.

### *Promoting materials circularity drives circular economic growth*

Increasing re-use, repair, remanufacturing and recycling rates is key to retaining the highest value of materials over their lifecycle. It helps to avoid unnecessary depreciation of valuable commodities and preserve the energy and value embedded in the product, while also reducing the demand for primary materials. At the same time, it can create new business opportunities. Some countries, for instance, set targets to increase reuse shares, which creates opportunities for repairers, refurbishers and newcomers. Increasing recycling rates can also potentially lower production costs of recycling companies through economics of scale and increase their competitiveness, whils recycled content standards can increase the demand for secondary materials. Scaling up markets for scrap material canalso boost profitability of the secondary materials production sectors. Moreover, investment in technologies and innovation to improve resource productivity and make processes more circular is central to sustaining green economic growth (OECD, 2015[24]).

### *Promoting materials circularity can achieve labour market goals*

Many countries see the RE-CE transition as an opportunity for job creation (Börkey, Linster and Laubinger, 2021[6]). Developing an economy based on re-use, remanufacturing and especially, repair, is more labour-intensive than a linear economy (EU, 2017[20]). In the same way, promoting recycling and secondary production of non-ferrous metals is more labour intensive than primary production (RREUSE, 2015[25]; The Club of Rome, 2015[26]; OECD, 2019[1]). Using policy to directly stimulate the output of recycling and secondary production may therefore achieve stronger employment effects than those obtained with a less targeted policy package (see Objective I). This is especially true for countries that import a large share of their raw materials requirements, which can thus replace imports with domestic economic activity.

In countries that import a large share of their raw materials requirements, replacing imports with domestic economic activity can lead to job creation domestically. However, in countries with a significant extractive sector, the net effect on employment may be negative and job gains in the secondary sector may in some countries be outdone by larger job losses in the extractive industry (see Objective I) (Chateau and Mavroeidi, 2020[19]).

### *Measures to encourage value retention and the substitution of primary with secondary production*

Policy makers can use certain instruments to increase the share of secondary materials in total materials and thus simultaneously achieve the aforementioned environmental, economic and labour market goals. Policy could focus on increasing the economic attractiveness of recovery and recycling, as this is essential to get more businesses and other economic actors involved. Indeed, many types of materials cannot be recycled cost-effectively, which is in part the reason why many classes of recyclable materials, such as recycled plastics, do not have well-established secondary markets for resale (OECD, 2018[27]). Policy makers can therefore help change the economic attractiveness of recovery and recycling by rolling out a combination supply and demand side policy measures.

### *Supply side measures to strengthening the secondary sector*

As discussed in Objective I, primary material taxes and recycling subsidies give the secondary sector an economic advantage, hence triggering a substitution from the use of primary to secondary materials in production processes. Another complementary approach to strengthening secondary production, recycling and recovery rates is to implement Extended Producer Responsibility (EPR) schemes. EPR schemes extend producers' responsibility for a product to the post-consumer stage of the product's life cycle. Therefore, they help to tackle the high costs of collection, sorting and processing of waste, which are often borne by municipalities. An EPR approach shifts the cost of waste disposal from municipalities to producers. This approach has proven to be effective in promoting higher recovery and recycling rates and in increasing financial support for waste management operations (Laubinger et al., 2021[13]).

However, the implementation of EPR schemes carries implications for the related product and secondary markets. The 2016 *Extended Producer Responsibility Guidance* highlights that they may affect competition, trade and welfare, either intentionally or unintentionally, primarily because they affect the sectors' cost structure (OECD, 2016[14]). For example, higher administrative and transport costs borne by importers may affect trade in a negative way. An increase in operational costs may also be passed on to consumers through higher product prices (Porter, 2002[28]). Moreover, costs of compliance with EPR schemes can be substantial, especially for smaller producers (Hilton et al., 2019[29]).

Furthermore, improving the quality of secondary materials is a key aspect to address when promoting the recycling and secondary sectors. Policies can focus both on upstream and downstream activities. With regards to the upstream part of the value chain, improving the initial design of products is essential. The choice of materials to produce the goods and the chosen design heavily influence the products' end-of-life management costs and recyclability. For instance, in the case of plastics, the combination of additives and polymers of different types and the mixing of different materials in municipal solid waste render the collection, sorting and recycling of end-of-life plastics rather costly, which can make recycling unviable (OECD, 2018[27]). Moreover, the presence of hazardous additives contained in plastic material reduces the possible applications and the value of its recycled form. To reduce waste and support the development of the secondary sector, policy makers should also encourage producers to pursue Design for Environment (DfE) (also known as eco-design) designing their products and packaging in ways that would (i) mimise the quantity of materials used in production; (ii) facilitate the repair and recycling of products and packaging at the end of their useful life; and (iii) avoid using materials that may pose a risk to human health or the environment (Laubinger et al., 2021[13]). Box 3.1 presents how eco-modulation of EPR fees in EPR schemes can be used to incentivise DfE. It should be noted that some aspects of DfE, such as the choice of more environmentally-friendly materials, may not be evident. For instance, research based on lifecycle impacts suggests that substituting plastics for alternative materials in consumer goods may, in some cases, impose higher environmental burden than would otherwise be the case (Boesen, Bey and Niero, 2019[30]; Trucost, 2016[31]). This is why policy makers should ensure that product designers consider the life-cycle environmental footprint of substitutes, as well as potential rebound effects in their design choices.

Regarding the downstream activities, improving recycling processes will result in higher quality secondary products, which can then be priced closer to virgin material prices. Through more comprehensive sorting processes, investment in recycling technology and smarter product design, it could be possible to offer recycled products that keep the intrinsic value of the initially recovered materials. Having well-established infrastructure is essential for producing large volumes of high-quality recycled materials. Achieving greater efficiency in recycling and reprocessing operations through technological improvements is also a significant step towards making recycling companies more competitive vis-à-vis producers of virgin materials. Because such technology often involves significant upfront costs, the allocation of public funds for R&D, loan guarantees and rollouts of public investment schemes may be required, especially in the recycling industry which faces low profit margins.

Finally, an important aspect of recycling markets worth addressing is the lack of standardisation of many secondary materials, which can significantly depreciate their resale value. This can constitute an important impediment to the economic viability of recycling. Promoting the development and use of quality specifications for the trade of secondary materials on marketplaces can be a solution to this issue.

### Box 3.1. EPR schemes with fee modulation

Producer responsibilities in traditional EPR schemes are often carried out collectively by producer responsibility organisations (PRO) which charge of an annual fee to producters. Traditionally, these fees are modulated based on relatively basic criteria, which have left to limited incentives for design for environment (DfE), as firms are minimally incentivised to invest in innovation that reduces the total cost of waste disposal, as this is likely to benefit all the other members (OECD, 2016[14]). Modulating fees in EPR schemes on more granular set of measurable criteria that represent their end-of-life impact offers a promising solution to strengthen DfE incentivises (OECD, 2001[32]; Walls, 2006[33]).

In a basic system, the fee often depends on a simple average of material (weight) or product type, which aims to represent differences in end-of-life costs. Weight-based fee modulation incentivises lightweighting, but besides that leads to minimal incentives for firms to improve product design.

In more advanced fee modulation, the fees are charged based on more granular end-of-life cost allocations. In theory, this would create stronger incentives for producers to change their product design. The increased complexity that an advanced fee modulation brings about would, however, also increase costs for administering and complying with the system. Advanced EPR fee modulation is likely to be most effective in product groups where the EPR fee makes a significant contribution to the overall product price, which makes these product groups more sensitive to fee changes. This is likely more the case in non-durable products, such as packaging (Laubinger et al., 2021[13]).

### *Strengthening the secondary sector through demand side measures*

The recycling sector is often characterised by the low scale of its processes, which is partly related to the issue of a complex product design, but is also due to the sparse geographical distribution of materials that have to be recovered. One way to increase the scale of operations and, therefore, enable firms to cut down on their unit production costs, is to reinforce the demand for recycled and recovered materials. Recycled content standards and Green Public Procurement (GPP) programmes are two prominent tools that policy makers can use. As previously discussed, allowing trade in high quality end-of-life products and materials can also contribute to creating economies of scale.

Mandating recycled content standards encourages the use of more recycled materials in manufacturing. Legislation on recycled content standards is not an economic instrument as such, but can operate in a similar way when the standard is set on an industry as a whole and when there is some flexibility with regards to the method of compliance. For instance, allowing industry players to trade compliance certificates (capped at a desired level) between each other could confer the economic flexibility needed to avoid excessive, burdensome compliance costs (Smith and Svatikova, 2020[34]). Recycled content standards can also be complemented with EPR schemes with modulated fees, where products that meet verifyable content thresholds can receive a bonus or a lowered fee. Although recycled content standards create a demand for recycled materials, they can do so only up to a certain level. The issue lies in the core incentive mechanism of standards because they, like most types of regulations, lack dynamic efficiency. Indeed, once the recycled content target is satisfied, there is no additional incentive to continue the progression towards including an increasing share of recycled materials in production processes.

The RE-CE transition can also be encouraged when governments put forward Green Public Procurement (GPP) guidelines which can specify resource efficiency and circular economy criteria in public tenders. For instance, GPP guidelines can set the level of recycled content that goods should meet in order to qualify for public purchase. As OECD countries spend on average 12% of their public budgets on procurement, they can exercise their purchasing power to promote the development of goods and services that meet desired characteristics (OECD, 2019[35]). By introducing environmental standards in the technical specifications, products can be standardised and the associated end-consumer markets can adapt, reinforcing the demand for these goods. When a sufficient production volume is achieved, other producers are more likely to adapt their production. GPP can therefore be a major driver for innovation, as it can provide the industry with incentives for developing goods and services that meet the desired technical specifications (OECD, 2019[36]). Prominent examples of GPP guidance include the Environmentally Preferable Purchasing Program provided by the U.S. EPA and the EU Circular Economy Action Plan, which aims to facilitate the integration of Circular Economy principles in GPP for the European Commission and EU member states (Börkey, Linster and Laubinger, 2021[6]). Policy makers should combine policies to reinforce their effect: a demand-side policy such as GPP can effectively complement a supply-side policy like EPR with fee modulation.

It should be underscored that certain environmentally desirable policies, such as GPP, may put excessive pressure on government budgets. Requirements imposed on public agencies to procure goods with minimum recycled content or environmental performance levels may make public purchases more expensive than they would have been otherwise. By specifying criteria, the product-quality ratio of purchases can also be diminished, given the limited nature of public funds (Smith and Svatikova, 2020[34]). However, by stimulating the market for greener products through GPP, these markets may become more mature and lead to benefits for private consumers and thus society.

### *Ensuring the realisation of potential synergies related to strengthening the secondary sector*

Market failures and barriers to scaling up circular economic activities can prevent the realisation of potential synergies. Such aspects include high search and transaction costs faced by buyers and sellers; consumer perceptions and risk aversion; technological externalities; uneven market power between virgin material producers and producers of recyclable materials can lead to market failures that impede the development of the recycling and secondary sectors (OECD, 2006[37]). Recycling markets can also be undermined when waste management is not properly addressed, such as when waste charges and fees fail to internalise environmental externalities associated with the products and therefore disincentivise their recovery (see Objective III). Moreover, when inefficient markets result in price volatility, investor uncertainty increases and further undermines the financial viability of recycling operations. Policy makers should, therefore, use a combination of tools to address the barriers and market failures in recycling and secondary markets to effectively promote the development of essential operations of the RE-CE transition.

## Objective 3: Managing waste to minimise associated environmental impacts

Addressing the environmental impacts associated with waste management is a key objective that can be stimulated by a carefully designed RE-CE policy package that exploits complementarities between policies influencing the different stages of the materials life cycle. The concept of the waste hierarchy can be a useful guide for waste management policy. In this concept, waste prevention is considered to be preferable to waste disposal, since it avoids emissions and environmental impacts related to the end of life of the material or product, and minimises demand for new materials and products. Waste can be prevented through product repair, refurbishments as well as through reduced consumption. The next best alternatives are the re-use of materials followed by materials recycling. However, as not all waste can be avoided nor recovered or recycled for useful purposes. As such, waste management options for remaining solid waste are ranked with respect to the environmental impacts they cause. Incineration with energy recovery and fitted with special gas-cleaning equipment is preferred to conventional incineration as it at least recovers the energy content of the waste materials. As a last option, sanitary landfilling helps to avoid public health issues compared with open uncontrolled dumpsites (OECD, 2019[10]). By aligning waste management policies and underlying incentive mechanisms with the waste hierarchy, policy makers can reduce environmental impacts, including emissions of waste and realise synergies with economic goals of the RE-CE transition.

### *Minimising unavoidable waste through pay-as-you-throw policies*

When the policy objective is to encourage household waste separation and minimise the amount of waste that cannot be of value anymore to the economy (hereafter "residual waste"), Pay-as-You-Throw (PAYT) schemes can be effective (ACR plus, 2019[38]). A recent review of waste collection systems performance in Europe showed that multiple countries that have PAYT systems in place generally present higher collection rates of recyclables and lower per-capita generation of residual waste (Börkey, Linster and Laubinger, 2021[6]). PAYT schemes apply the "polluter pays principle" by charging a variable fee on the quantity or volume of household waste (in addition to a fixed fee in some systems). Households are consequently incentivised to generate less non-recyclable waste, as they have the possibility to lower their bills. In the same way, municipalities can reduce expenditures related to waste management, as this often falls under their responsibility. At the same time, however, PAYT schemes may be laborious to implement, especially when there are many different municipalities involved, as each of them would require specialised expertise and equipment. This often results in municipalities being reluctant to implement PAYT, thereby eliminating a large potential for municipal waste reduction. It is worth underlining that there is a cost-saving potential if municipalities join forces, as they might benefit from economies of scale when performing waste sorting activities and might be able to afford costly technologies to facilitate these processes (Smith and Svatikova, 2020[34]).

### *Incentivising the waste hierarchy*

In the context of waste policy, taxes are used to internalise the environmental cost of waste treatment and disposal and can be used to encourage alternative treatment methods. Landfill taxes can be used to divert waste streams from landfilling to the next best waste treatment alternative. Because they have proven to be effective at reducing landfilling when they are set to a sufficiently high level, they can be a useful instrument for countries in which landfilling is still the dominant practice (Smith and Svatikova, 2020[34]). By diverting waste to incineration facilities, more land becomes available which can be used for productive activities. Indeed, incineration allows to reduce the initial waste volume by up to 90% (Neuwahl et al., 2019[39]) Similar to landfill taxes, incineration taxes can be levied on incinerators without energy recovery to divert waste streams towards incineration facilities with energy recovery and recycling activities. Although neither the incineration nor landfill taxes are effective at incentivising households to separate their waste or engage in recycling, both are helpful in strengthening the effect of RE-CE policies aimed at changing these behaviours.

To effectively incentivise the waste hierarchy, it is essential that economic instruments capture the full social cost of waste disposal, which includes the costs of externalities, such as those associated with environmental damage (e.g. contamination of groundwater through landfill leachate or methane emissions released into the atmosphere) (McCarthy and Börkey, 2018[12]). Policy makers can benefit from using a holistic approach when aiming to encourage better waste management and reduce associated environmental impacts in the context of the RE-CE transition. They can combine different economic instruments to strengthen their effects but can also make use of regulatory instruments to complement unaddressed issues. For instance, preventing contamination from certain chemical elements might be more effective through regulatory bans than waste charges and taxes.

## Objective 4: Building economic resilience and reducing geopolitical supply risks through materials circularity

The global economy relies extensively on non-renewable raw materials of wich many tend to be clustered geographically. For example, China accounts for over one-third of the world's reserves of rare earth elements deposits (USGS, 2021[40]) and around 90% of global production (Coulomb et al., 2015[41]). Previous analysis shows that material supply criticality is a challenging topic, and that it is primarily linked to geopolitical tensions, rather than physical availability (Coulomb et al., 2015[41]). The exhaustion of economically competitive mineral deposits in industrialised countries has made supplies increasingly dependent on the political stability of a few mineral-rich emerging economies (Coulomb et al., 2015[41]). This becomes problematic when there is low substitutability in current applications and low recycling rates, which is the case for many rare metals and minerals extensively used in modern technology (Table 3.1).

### Table 3.1. Estimates of global recycling rates and recycled content of metals

| | End-of-life recycling rate (%) | Recycled content (%) |
|---|---|---|
| *Ferrous metals* | 70 | 40 |
| Aluminium | 55 | 35 |
| Chromium | 90 | 19 |
| Copper | 50 | 30 |
| Gold | 50 | 30 |
| Manganese | 53 | 37 |
| Nickel | 60 | 35 |
| Silver | 65 | 30 |
| Tin | 75 | 22 |
| Zinc | 40 | 23 |
| *Platinum-group metals* | | |
| Indium | 25 | 17 |
| Palladium | 65 | 21 |
| Platinum | 70 | 20 |
| Rhodium | 55 | 40 |
| Ruthenium | 10 | 55 |
| *Other metals* | | |
| Antimony | 20 | 5 |
| Cobalt | 32 | 68 |
| Indium | 0 | 38 |
| Magnesium | 39 | 33 |
| Molybdenum | 30 | 33 |
| Niobium | 53 | 22 |
| Rhenium | 17 | 60 |
| Tantalum | 5 | 20 |
| Tungsten | 46 | 40 |

Note: Recycled content refers to the secondary content of the refined metal production.
Source: (OECD, 2019[1]) based on UNEP (2011[42]).

Policy makers can counter these issues and create another important set of synergies related to securing the supply of materials, by by developing strong domestic recycling and secondary sectors and tapping into the large, unrealised potential of recycling. In importing countries especially, sourcing materials domestically, through re-use and recycling could lower their reliance on imports of some materials, which improves material security and may also lead to material cost savings. However, while increasing recycling and recovery rates of materials has been found to reduce imports of secondary raw material, there is so far little evidence that it affects the import levels of primary materials (Dussaux and Glachant, 2018[43]). It also allows to better shield national economic activity from international commodity price fluctuations. Finally, higher recovery and recycling rates can also present opportunities for economic and employment growth, as discussed in Objective II. Strengthening the secondary sector is also strongly aligned with political ambitions of the 3Rs framework, Sustainable Materials Management, and the Nationally Determined Contribution targets of the Paris Climate Change Agreements.

Implementing domestic RE-CE policies to achieve these objectives carries market implications. For instance, domestically sheltered activities might become less competitive (Bleischwitz et al., 2017[44]). Recycled materials such as ferrous scrap are traded on international markets and prices are set through global changes in supply and demand. However, it becomes less clear how commodity prices behave when the market is closed domestically. Moreover, any type of public subsidy can have undesirable effects on industry dynamics as it may keep inefficient firms in business. It may also open the door to WTO disputes if they are found to distort international market prices or have other adverse effects on international trade. This can be avoided if government support remains within the boundaries provided by the Agreement on Subsidies and Countervailing Measures (ASCM) (WTO, 2021[45]; Yamaguchi, 2021[17]).

# 4 Interaction with other policy domains

A transition to a resource-efficient and circular economy can complement and create synergies with other environmental policy issues and thus reduce overall economic and welfare costs that they induce. By deepening the understanding of interconnectedness between different policy areas, policy makers can ensure better policy alignment and accomplish numerous goals simultaneously while avoiding possible trade-offs.

## RE-CE policies and their interaction with low-carbon transition policies

Bibas, Chateau and Lanzi (2021[16]) find that adding the policies targeted at reducing the use of fossil fuels and achieving a low-carbon economy to a RE-CE policy package further decreases primary materials use at no additional cost to the economy. In fact, the reductions in materials use achieved by the two sets of policies individually are largely additive when the policies are combined with each other. The modelling results also show that this combination could even stimulate employment in OECD and BRIICS countries, with only a small impact on wage rates. Furthermore, adding energy policies to RE-CE policies can mitigate some of the GDP losses experienced by some countries due to primary material taxes. This is especially true for BRIICS countries, which can benefit the most from simultaneously pursuing the energy transition and RE-CE objectives.

The technologies required for the transition to a low carbon economy can, however, lead to potential trade-offs with the RE-CE goals. For instance, photovoltaic (PV) solar panels, one of the flagship technologies of the energy transition, do not seem to be compatible yet with the principles of making modular, easy-to-disassemble designs encouraged by the RE-CE transition. Solar PV innovation is thus necessary to make designs that can be easily recycled and thus align with the environmental goals of the RE-CE transition. Moreover, as with any other modern technology equipment, many renewable and low carbon technologies rely on minerals and metals with supply constraints, due to limited reserves, their geographic concentration or due to the overall geopolitical environment. Many rare earth elements can hardly be substituted with other materials. As such, promoting recycling and re-use of such elements (e.g. germanium, cobalt, antimony, tungsten) could alleviate potential supply risks and can to some extent also build domestic resilience against commodity price fluctuation (see Objective IV). However, recycling methods of certain materials required by the resource efficiency and low carbon transition are not yet well-established and therefore require innovation. For instance, carbon fibre-reinforced plastics are increasingly used to reduce the weight of vehicles and aircrafts and thus achieve fuel savings, but the technology to recycle them remains premature (IEA, 2020[46]).

## The RE-CE transition in the context of the Covid-19 economic recovery

The Covid-19 pandemic and the resulting lockdowns and response measures that local governments have put in place to curtail it have caused severe economic, as well as environmental impacts, also affectin materials use (Dellink et al., 2021[47]). Biotic (agricultural) materials are linked to agriculture, which was less severely affected in 2020 than most other sectors, and which are projected to quickly rebound to around 1% below baseline. For metals, the short-term effect was very small, as most industrial activity that uses metals remained relatively undisturbed. This holds especially for upstream activities such as melting, whilst downstream sectors such as car manufacturing were more extensively disrupted. But the projected negative long-term effect on manufacturing production in the coming years gradually brings down metals use further below baseline levels. The effect for non-metallic minerals was significant in 2020 and linked to the sharp decline in construction activities in 2020. The associated long-term effects depend crucially on the way recovery packages are designed and the resulting impact on construction activities.

To tackle this economic crisis, OECD governments have allocated USD 3,200 billion to Covid-19 recovery packages as of December 2021 (OECD, 2021[48]). Value retention, a key objective of the RE-CE transition, is in principle perfectly aligned with the ambitions of increasing economic resilience and pursuing economic recovery. Numerous investment opportunities can pursue these ambitions simultaneously. As emphasised in Objectives II and IV, investing in collecting, sorting and recycling infrastructure is a precondition to retaining economic value in the economy and building resilience against supply risks. Another example relates to reducing energy consumption and increasing resilience against days with extreme heat or cold weather through better insulation in buildings and homes. But such efforts require a focus in the recovery packages on stimulating the transition to a resource-efficient, circular economy, rather than using the packages to prop up existing industries that rely on a linear use of materials. Furthermore, the investments needed to spur the RE-CE transition have impacts on public debt and have to take into account long-term fiscal sustainability. Collecting revenues from primary material and carbon taxes could help in this regard.

## RE-CE policies and their interaction with transport policies

Finally, policy makers who pursue the RE-CE transition can also take advantage of the interplay between the policies needed for the transition and other policy domains such as transportation policies. Given societies' ever-growing reliance on transport systems running on fossil fuel, and the large share that the transport sector represents in total $CO_2$ emissions from fuel combustion (24%), the switch to low-carbon transportation has been promoted (IEA, 2021[49]; OECD, 2015[50]). Some countries have therefore taken steps to scale-up innovation in electric, hybrid and hydrogen-based vehicles. On the demand side, adopting circular business models can yield numerous benefits, which is why it has attracted much attention in recent years. For instance, developing multi-user business models such as carsharing could significantly reduce the number of vehicles in a city and tackle high congestion and pollution levels (Ellen MacArthur Foundation, 2015[51]). Moreover, this could drive down the dependence on imported steel (Ellen MacArthur Foundation, 2015[51]; OECD, 2021[52]). However, pursuing different policies in parallel without coordination can lead to policy misalignments (e.g. energy subsidies as a social policy may undercut the effectiveness of energy taxes). Implementing coherent incentive mechanisms that reinforce each other, to the extent that it is possible, and aligning policies such that incentives for consumers and producers fit with the overarching policy objectives is therefore key.

# 5 The need for international co-operation

Global commitment and international co-operation underpin the effectiveness of policies aiming to improve resource efficiency and decrease environmental impacts of resources used. Given that the current economy is characterised by complex global value chains, in which production processes are sliced thinly across borders and traverse multiple jurisdictions before final consumption, the production of goods is exposed to different regulations and varying levels of environmental policy stringency (Yamaguchi, 2021[17]). Due to these global value chains, associated environmental impacts also often occur in places remote from where the final consumption takes place. This increases the risks of trade-offs between policies – and especially between regions – and requires policy alignment and international coordination.

At the same time, because specialised actors have undertaken supply chain activities that they can perform cost-effectively, GVC have led to a substantial increase in the productivity of economies and of materials use in the past decades. However, the fragmentation of value chains has increased the complexity of their management, making it more challenging to identify and realise resource efficiency improvements. More complex value chains also increase the risks that policy instruments do not achieve their full intended potential and thus the risks of trade-offs between different objectives. Furthermore, international markets for end-of-life products are essential to scale up circular activities but mired in complex trade regulations. For these reasons, there is a strong need for wide-ranging international co-operation to build sustainable supply chains that align with RE-CE goals (OECD, 2016[53]; Yamaguchi, 2022; forthcoming[54]).

Globally coordinated RE-CE policies would amplify their positive outcomes. For instance, broader policy adoption of primary material taxes and recycling subsidies has been found to amplify the decoupling of economic growth and global materials use (Dellink, 2020[18]; Bibas, Chateau and Lanzi, 2021[16]). However, there is a strong economic rationale for highly specialised countries that have a competitive advantage in the production of raw materials-related commodities to opt out of RE-CE policy packages, since they can prevent major GDP losses in this way. When these countries do so, the effectiveness of RE-CE policies is undermined. Indeed, as a result of lower international prices induced by lower demand from countries implementing the policies, the other specialised countries which opted out will tend to increase their materials use. For instance, (Dellink, 2020[18]) finds that if all net exporters opt out of an environmental tax reform policy, most of the materials use reductions vanishes, especially for metals.

# 6 Synergies need to be developed between RE-CE and trade policies

Recent work by Yamaguchi (2021[17]) identifies potential synergies that can occur between RE-CE policies and trade policies, while also pointing out cases in which international co-operation is essential to achieve policy alignment. Indeed, the two policy domains are intertwined. While RE-CE policies largely take place within national boundaries, their effects often extend internationally. For instance, international waste trade is influenced by domestic EPR schemes specifying recycled content criteria. By exchanging global information essential to the mechanisms underlying EPR schemes, governments can tackle the issue of illegal waste trade and free-riding from online sales (Hilton et al., 2019[29]). Moreover, establishing mutually recognised material quality standards for secondary raw materials and standards for sustainable production can facilitate international trade when pursuing the RE-CE transition. Indeed, regulatory fragmentation and the number of jurisdictions GVC are subjected to often lead to varying standards which raise concerns for international trade and market access for the private sector, especially when it pursues RE-CE business models. Therefore, the harmonisation of RE-CE related standards or mutual recognition of conformity assessment procedures would help avoid regulatory heterogeneity and associated trade costs. Another issue to tackle is the lack of harmonised definitions and classifications of waste, scrap and secondary materials in different jurisdictions. Clarifying Harmonised System (HS) codes for waste, scrap, second-hand goods and goods for refurbishment and remanufacturing could improve policy makers' understanding of the issues at hand to facilitate the transition and improve trade in secondary materials (Yamaguchi, 2021[17]). Current HS codes, unfortunately, cannot adequately identify secondary materials from waste and scrap, making policy action to improve RE-CE objectives in international trade more difficult (OECD, 2015[24]; Yamaguchi, 2021[17]).

## ELIS schemes as a tool to harmonise and promote sustainable trade

Environmental labelling and information schemes (ELIS) are useful instruments in the domestic RE-CE transition for improving resource efficiency by enabling more informed purchasing choices for consumers and firms (Laubinger and Börkey, 2021[55]). However, when implemented in an uncoordinated manner across countries, their effectiveness may be compromised. ELIS should be internationally harmonised to maintain high environmental standards and, at the same time, decrease the costs associated with labelling duplication across jurisdictions. Manufacturers aiming to make their production more sustainable could thus know to which environmental standards they should turn, and by the same token, acquire international recognition for their positive change and be further incentivised to continue their progress. Thus, monetary and environmental synergies can be reaped by coordinating ELIS across countries.

## International co-operation is needed for the RE-CE transition

Moreover, policy action at the international level can help alleviate barriers to trade that are responsible for limiting the distribution of the best available environmental technologies and reducing the scope and scale of resource efficiency improvements (OECD, 2016[53]). Such barriers notably include barriers to foreign investment and national export restrictions on raw materials, used products and environmental services (OECD, 2016[53]). Yamaguchi (2021[17]) also points out that policy makers can take advantage of the mechanisms underlying international frameworks (e.g. Basel Convention, WTO, OECD) or Regional Trade Agreements to enhance co-operation on trade and circular economy issues by including specific resource efficiency and circular economy provisions. Finally, as set out in the *OECD Policy Guidance on Resource Efficiency* (OECD, 2016[53]) and *the OECD Recommendation of the Council on Resource Productivity* (OECD, 2008[3]), strategic deployment of Official Development Assistance (ODA) to developing countries that targets resource productivity goals should be encouraged. By aligning development finance with resource productivity goals, ODA can facilitate the deployment of capacity needed for improving resource efficiency and enable faster technology transfer between countries.

# 7 Final remarks

The transition to a resource-efficient and circular economy requires large-scale adjustments of economic activities. The use of primary materials that leads to significant environmental damages can be curtailed, secondary markets can be stimulated, waste management can be improved to increase recycling, all while improving security of supply of essential resources for sustainable economic growth. The potential for economic, environmental and social benefits of a resource-efficient and circular economy transition will only be realised if policies are coherent, synergies are exploited, and if the major trade-offs are either avoided or mitigated. International coordination is vital, not only for economic reasons.

As this paper has shown, recent OECD analyses of policies for a transition to a more resource-efficient and circular economy provide the toolkit for governments to take more ambitious actions; the associated modelling analyses show that the transition can bring significant environmental gains, while preserving economic growth and social objectives, and potential negative implications are addressed with effective flanking policies.

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**Synergies and trade-offs in the transition to a Resource-Efficient and Circular Economy**

As the global economy expands and living standards rise, the world's raw materials consumption is expected to nearly double by 2060. This is particularly alarming because materials extraction, processing, use and waste management lead to very significant environmental pressures, ranging from local pollution at mining sites to GHG emissions from metal processing or air pollution from waste handling and disposal. A circular economy aims to transform the current linear economy into a circular model to reduce the consumption of finite material resources by recovering materials from waste streams for recycling or reuse, using products longer, and exploiting the potential of the sharing and services economy.

This paper underlines the synergies policymakers can create between different resource-efficient and circular economy transition objectives when designing policy packages. It also highlights potential trade-offs that may arise in their implementation. The paper shows that the existing OECD policy analysis provides a toolkit for governments to take more ambitious actions toward a resource-efficient, circular economy. In addition, OECD modelling studies project that the transition can bring significant environmental gains while preserving economic growth and social objectives, when complemented with flanking policies addressing potential negative implications.

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