CHAPTER 13:
National Government

Increasing resource productivity by reducing, reusing and recycling waste could contribute to economic growth and reduce environmental impacts. Three types of national-level policy options could achieve this: pricing and market-based approaches; regulatory approaches; and strategic approaches. This chapter offers detailed policy recommendations in each of these categories, supported by extensive evidence of what works from around the world.

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Introduction: why should policymakers be interested in resource productivity?

Resource productivity is a measure of the effectiveness with which an economy, or sector of the economy, generates added value from the use of resources. It can be expressed as the ratio of economic value (or output) to resource consumption (or input). Put simply, resource productivity amounts to getting more value out of the same, or less, resource input. From the perspective of the national-level policy maker, resource productivity is important for several reasons.

1. Contributing to economic growth

Increasing resource productivity increases the amount of wealth that can be generated from any given amount of resource – in other words, as with labour productivity, higher resource productivity contributes to wealth creation. Strong evidence for this assertion is provided by recent modelling for the International Resource Panel (IRP), an expert group of scientists founded by the United Nations Environment Programme (UNEP). It found that resource efficiency policies could boost GDP within G7 countries by 3% by 2050, compared to a business-as-usual scenario. For the world as a whole, the economic boost is even greater: up to 6% higher gross world product (GWP) by 2050, compared to business-as-usual[1].

For the UK specifically, increasing the resource productivity of the economy could have significant effects in creating new skilled jobs in industry. For a number of decades, the UK has become increasingly import-dependent in terms of resources, as its economic structure has shifted towards one of import-oriented service-based activities. Since the 1990s, the share of manufacturing in the UK's GDP has declined, while services have increased[2]. This has had mixed effects. In some areas, especially the south-east of England, the services and financial economy has thrived, contributing to job creation and growth. In other areas, especially those traditionally linked to manufacturing and heavy industry, unemployment rates still tend to be persistently and substantially higher than the UK average[3].

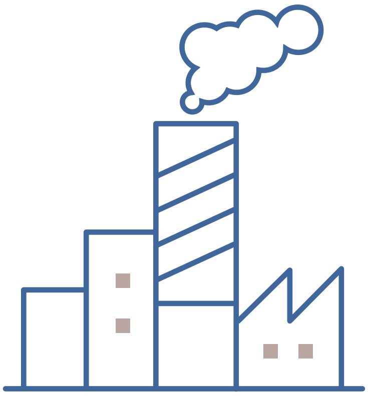
Resource productivity in the economy entails a shift away from simply importing products, and disposing of or exporting wastes. It involves retaining materials before they become wastes, and finding innovative ways of reusing them; as well as finding innovative ways to use fewer resources in the first place. Technologies such as 3D printing, practices such as eco-design and industrial symbiosis, and business models based around servicing, repair, remanufacturing and extended producer responsibility, are central to a resource productive economy, and all have the potential to create new jobs and reinvigorate the economy. Such new employment opportunities may be well correlated to the sectors and geographical regions currently experiencing highest unemployment, due to the good match between existing skill sets in areas of declining industry, and the skill sets required in new resource-productive jobs. As such the resource productive economy could create wider social benefits by redressing the structural imbalance of unemployment[3].

2. Resource availability

The availability and accessibility of different resources varies greatly. Some have large reserves, distributed across many global regions; in other cases, reserves are much less plentiful and under greater pressure. Access to some metals and minerals is further limited by the geographical concentration of economically recoverable reserves[4,5], and in the case of a vital resource such as water, in several regions of the world the rate of consumption exceeds the sustainable rate of renewal. Projections suggest that under business-as-usual conditions, overall global material resource demand will more than double by 2050 (ref. 1). Providing such quantities of resources may or may not entail absolute shortages of some resources, but the increasing challenges of delivering them through all the uncertainties of the business cycle would be very likely to lead to price spikes and volatility. A more resource-productive economy would not be as vulnerable to such price movements. Examples of resources and materials with particular availability concerns are water, land and biomass, with increasing uncertainties due to climate change; some metals, including those considered 'critical' due to growing demands and limited availability in nature, such as lithium and cobalt which are used in batteries[4,5]; and elements such as nitrogen and phosphorus that are important agricultural inputs[6,7].

3. Cost-effective greenhouse gas emissions reduction, and offsetting of other mitigation costs

The greenhouse gas (GHG) emissions generated during the production and manufacturing of products from resources and raw materials are substantial. Resource productivity has strong potential for cost-effective reduction of GHG emissions, especially when the GHG emissions of the whole resource lifecycle are considered. A clear example is the comparison of the production of recycled metals with metal produced from ores. For some metals, recycling can reduce energy demands by as much as 90%, compared to metal produced from ores, with this energy reduction typically resulting in a similarly substantial reduction in GHG emissions[1].



Resource productivity may thus provide an **important justification** for re-shoring in the UK some industrial and manufacturing activities

Of course, if GHG emissions are measured on a production basis, then increased resource-productive industrial activity in the UK that substitutes for imports may increase UK emissions, while reducing those in the exporting country. But global emissions will be reduced, which is what counts for climate change mitigation. Resource productivity may thus provide an important justification for re-shoring in the UK some industrial and manufacturing activities in a way that is consistent with global decarbonisation objectives, as well as having important socio-economic benefits that are discussed further below (see 'Strategic approaches' on p179).

Part of the same modelling exercise cited above shows the contribution that resource productivity could make to the climate agenda[8]. First, in comparison to a business-as-usual scenario, resource productivity policies alone would succeed in reducing global GHG emissions by 19% in 2050, even without specific climate-focused policies. When resource productivity policies are added to a scenario that already has stringent climate policies, the GHG reductions are further enhanced. Whereas a scenario with only climate-focused policies reduces GHG emissions by 56% from 2015 levels by 2050, adding resource productivity policies pushes the reduction to 63%.

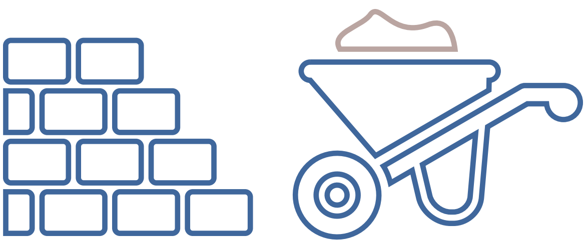
Furthermore, the modelling suggests that resource productivity policies could more than offset any costs associated with climate mitigation. Whereas the climate-policy-only scenario sees a GWP loss of 3.7% in 2050 compared to the business-as-usual scenario, the addition of resource productivity policies as well as climate policies sees GWP increased by 1.5% in relation to business-as-usual by 2050 (ref. 8).

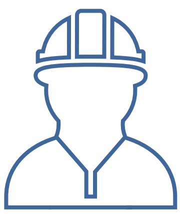
4. Reduction in other environmental impacts

As well as GHG emissions, the use of resources produces other environmental impacts at every stage: extraction, production, use and disposal. These can include, depending on the resource: contamination of water and soil; destruction or degradation of productive land or ecological habitats; and airborne pollutants. The more productive use of resources is critical to enable humans to continue to extract and use resources, while reducing environmental impacts[1].

National-level policy approaches for resource productivity

Resource productivity policies as devolved to the local government level have been discussed in Chapter 12, and various other chapters have discussed the impacts of policies on particular sectors, for example household and municipal (Chapter 4) and industrial and commercial (Chapter 5). This section looks more broadly at national-level policy approaches to increasing resource productivity, with some examples of each type. It considers available national-level policy options in three categories[9]: pricing and market-based approaches; regulatory approaches; and strategic approaches. In each case, it draws on evidence of national-level policies implemented in the UK as well as in other countries.





An important economic driver of resource efficiency is the relative cost of **materials** and **labour**

Pricing and market-based approaches

1. Waste taxes and charges: The UK Landfill Tax, and pay-as-you-throw charges

The Landfill Tax was the UK's first explicitly environmental tax. The tax is charged at a 'standard rate' for waste that decays, such as household waste, which is known as active waste; and a 'lower rate' for inactive or inert waste, such as sand and concrete[10].

When first proposed by Kenneth Clarke, the Chancellor of the Exchequer at the time, in his budget of November 1994, it was suggested that the tax could be revenue-neutral, as corresponding reductions would be made in employer National Insurance contributions. In response to a consultation paper on the Landfill tax in 1995, local authorities expressed a number of concerns, including the lack of incentive the tax offered to householders to change their behaviour[11].

The Landfill Tax came into operation on 1 October 1996, at a standard rate of £7 per tonne and a lower rate of £2 per tonne. From 1 April 1999 the standard rate rose to £10, and an escalator of £1 per year was introduced for the subsequent 5 years.

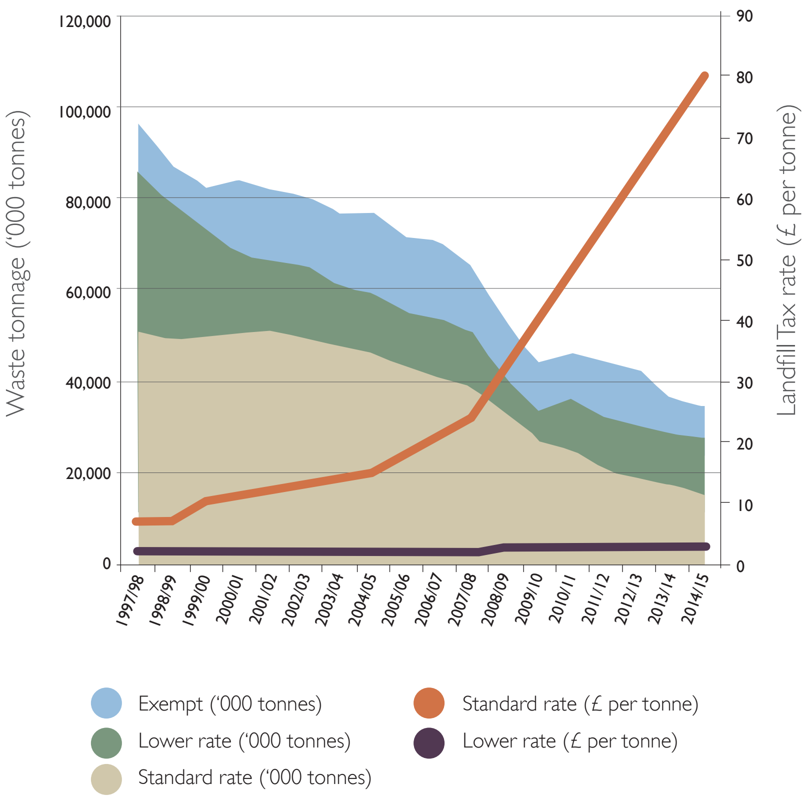
The government's 2002 pre-budget report promised to consult on a "revenue neutral" proposal to increase the escalator to £3 per tonne per year, towards a medium to long-term level of £35 per tonne[12]. In 2008, the escalator rose to £8 per tonne per year, with the lower rate rising for the first time, to £2.50. The Economic Secretary to the Treasury explained that the impact on local authorities of the increased cost was taken into account in the local government settlement, which included an annual increase in funding of 1% above inflation[12].

As shown in Fig. 1, the £8 escalator for standard waste was then maintained until 2014/15, when the standard rate reached £80 (with the lower rate still frozen at £2.50). Thereafter both rates have increased in line with inflation only. They currently stand at £84.40 per tonne (standard rate) and £2.65 per tonne (lower rate), raising more than £1 billion per year in revenue (see Fig. 2).

The landfill tax provides a strong incentive for local authorities to undertake separated waste

Figure 1: *Waste tonnage sent to landfill, and Landfill Tax rates.*

HMRC Tax and Duty Bulletins: https://www.uktradeinfo.com/Statistics/Pages/TaxAndDutyBulletins.aspx



collection and recycling from households. These issues are discussed further in Chapters 4 and 12. However, as noted numerous times during its development[11, 12], the Landfill Tax is not directly faced by householders. Whatever its effect on recycling by local authorities, it gives no direct incentives to householders to reduce their quantity of non-recyclable waste.

An alternative approach for household waste would be variable waste charging, also called pay-as-you-throw (PAYT) schemes. Under such schemes, households are charged for waste disposal on the basis of the weight or volume collected, providing a financial incentive to households to reduce their waste generation. Such schemes have been applied in many countries around the world, and they generally have a positive impact on waste prevention[13]. A review of studies from countries in the Organisation for Economic Co-operation and Development (OECD) found that variable waste charging "generally goes hand in hand with a 15-30% increase in recycling and a sharp fall in landfilling"[14]. Successful versions of variable waste charging have also been developed in Italy (see case study on p179).

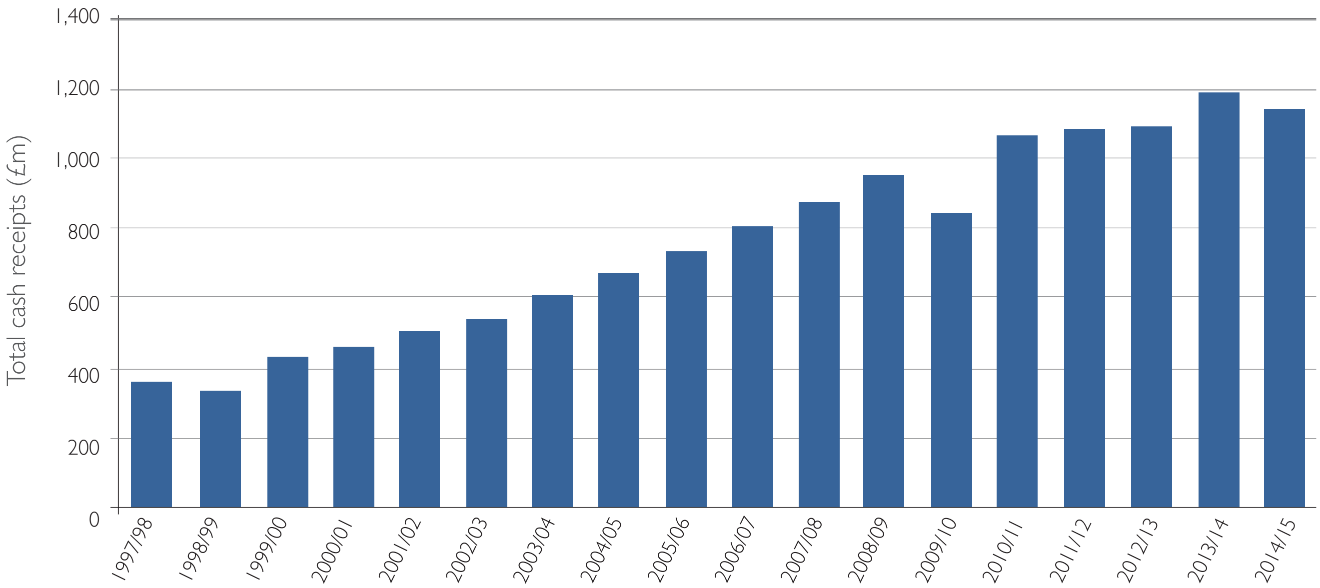
In the UK, however, local authorities (which are bound by the 2011 Localism Act) do not have the power to directly incentivise waste reduction, for example through PAYT schemes. Nevertheless, Blaby District Council in Leicestershire began a limited form of waste charging in 2001. The council provided residents with one 140 litre refuse bin and one similarly-sized recycling bin; residents were able to request additional refuse sacks or a larger refuse bin, but for a fee. Within the first year of the scheme, only 7% of households were renting a larger refuse bin or buying more refuse sacks, and it was reported that recycling collections had risen by 55% (ref. 17a). Also within the first year of the scheme, waste to landfill was reported to have been reduced by 3% (ref. 17b). Blaby District Council still operates this scheme, whereby households requiring greater refuse storage than the standard 140 litre bin incur a charge[17c]. Its recycling rate currently stands at around 49% (ref. 17d), which is higher than the UK average[17e]. The council has also recently received central government funding to run a three-year incentive scheme to reward households whose recycling bins are uncontaminated by non-recyclable refuse[17f].

The Landfill Tax affects other sectors as well as households. In 2012, total UK waste generation was 200 million tonnes (Mt), spread across various sectors (see Fig. 3). The largest sectoral generator of waste was construction and demolition, which generated around 100Mt of waste. By excluding excavation waste – such as excavated soil, mineral waste and dredging spoils – this falls to about 45Mt, 87% of which was recovered. This exceeds the 2020 recovery target of 70% for construction and demolition waste under the EU Waste Framework Directive.

Figure 4 shows the split between quantities of waste sent to landfill compared to other final treatments, for different waste streams. A few of these waste streams stand out as having relatively large proportions and absolute quantities being sent to landfill. About 60% of the 'household and similar' waste stream, or

Figure 2: *Total cash receipts from Landfill Tax.*

HMRC Tax and Duty Bulletins: uktradeinfo.com/Statistics/Pages/TaxAndDutyBulletins.aspx

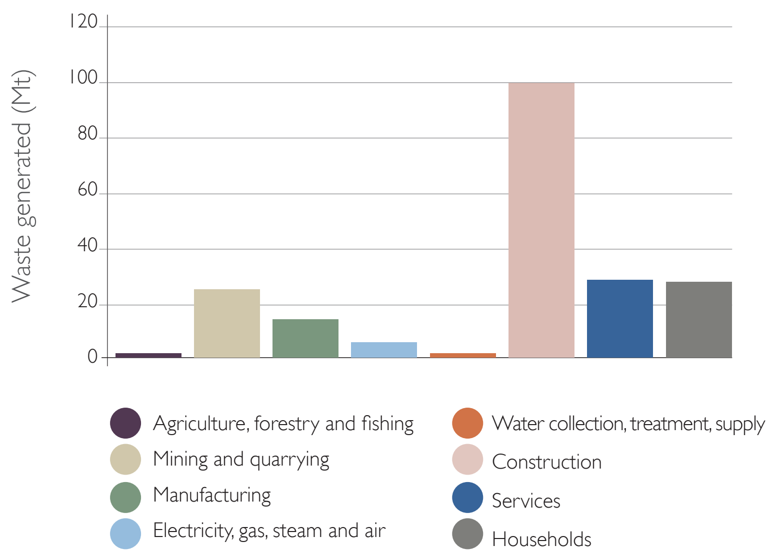


about 11Mt, is sent to landfill (this overlaps with, but is not directly equivalent to, the household sector shown in Figure 3). About 90% (10Mt) of 'sorting residues' – which includes residue waste from "mechanical sorting processes, refuse-derived fuels, non-composted residues from composting, etc"[19] – is sent to landfill. About 50% (18Mt) of soil waste, mostly excavation waste from construction and demolition, is sent to landfill. Though smaller in absolute quantities, high proportions – around 90% – of the wastes under the categories 'mineral wastes from waste treatment and stabilised waste', and 'combustion wastes', are sent to landfill. In absolute terms, the landfilled wastes under these categories are around 2Mt and 4Mt respectively. A more detailed statistical breakdown of the composition and origin of the waste that is still sent to landfill may be an important step to identifying measures to divert and reclaim such materials, including through creating "industrial symbiosis" synergies, joining up the material flows of different industries (see Chapter 11, case study on p157).

Other market based instruments can also affect the use and disposal of material resources. The UK's energy policy includes incentives to promote renewable and low carbon sources

Figure 3: *Total generation of waste in the UK by economic activity, 2012.*

Defra[18]



of energy. These include incentives, through the Feed-in-Tariff Contract for Difference (FIT CfD) regime to promote energy recovery from waste. Reclaiming energy from waste is clearly an effective way of avoiding waste going to landfill. However, it also prevents the recycling of any useful material that may have been present in the waste; and if incentives are not set at the right level, there is theoretically the possibility of creating incentives for the generation of waste, as an energy source, which may not be an efficient or effective way of reducing material consumption or carbon emissions. Hence the ongoing effect of the FIT-CfDs on waste generation and treatment should be monitored.

2. Aggregates taxes (or virgin material taxes)

Landfill taxes and other waste charges are taxes on waste at the point of disposal. Their direct incentive therefore is for the avoidance of landfill, and they do not necessarily incentivise more energy- and material-efficient practices moving further up the material management hierarchy (eg reduce, reuse). By comparison, a tax on virgin materials would theoretically have effects across the whole supply chain, and incentivise measures at every rung on the resource management hierarchy. In the UK there is an Aggregates Levy on sand, gravel and rock, whether dug from the ground, dredged from the sea in UK waters or imported[20]. UNEP envisages the application of just such extractive taxes across a range of materials, adjusted periodically according to increases in efficiency, to deliver revenue neutrality[21].

3. Rebalancing the cost of labour and materials

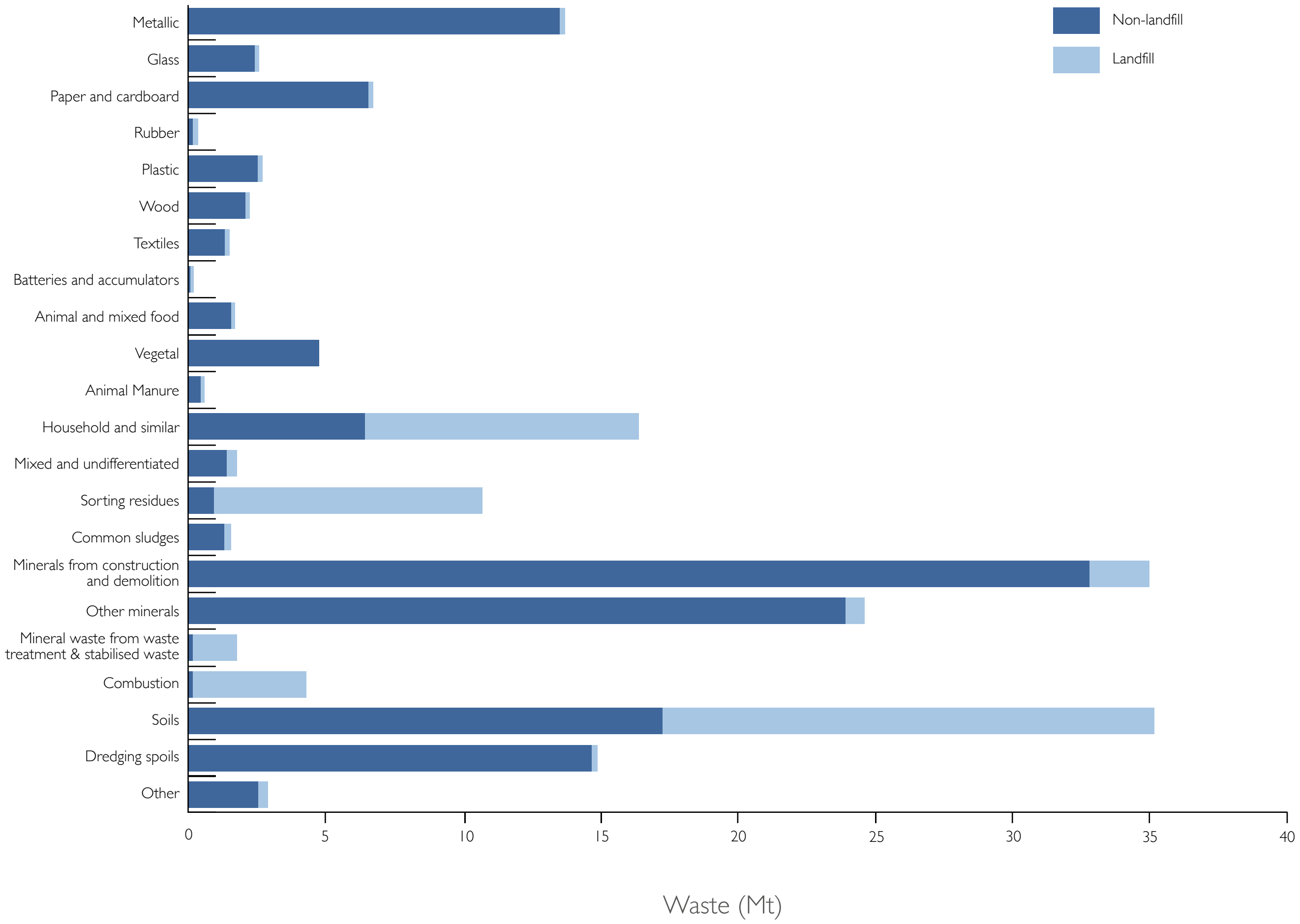
Recapturing the value of materials that would otherwise be disposed of as waste usually requires labour. Consequently, an important economic driver of resource efficiency is the relative cost of materials and labour. Resource efficiency and economic efficiency are not always aligned, and resource-inefficient behaviour can, sometimes, be more cost-effective than resource-efficient behaviour[1]. This can be the result of an economically rational calculus of the relative costs of materials, and of the labour that would be required to avoid wasting them[1, 21, 22a]. Therefore, national level policy measures that reduce labour costs relative to the cost of materials could help realign resource efficiency with economic efficiency. Examples of measures to reduce labour costs for resource productive activities could include reductions in employers' National Insurance contributions; or, as has recently been proposed in Sweden, cuts in the VAT charged on repair work, and tax rebates for the labour cost of repairs, which will significantly reduce the cost to consumers of repairing appliances[22b].

If reductions in labour costs are balanced against measures that increase costs of materials or of waste disposal, a combination of these approaches could promote resource efficiency in a way that was revenue-neutral for the government and for businesses. Indeed, Labour and Conservative governments invoked this principle as they introduced and subsequently increased the Landfill Tax. Compensatory reductions in employer National Insurance contributions were introduced to avoid increasing the tax burden on businesses, invoking the principle that the tax system should encourage work, and discourage environmental pollution[11].

4. Financing

Resource-efficient investments can often be inhibited because commercial banks are unable to finance projects with long-term payback periods. Government could potentially intervene to guarantee long-term loans, or to provide them directly, for example through the Green Investment Bank (GIB). There is a risk, however, that some more advanced material and resource efficiency concepts may fall outside of the GIB's current investment sectors. If the GIB is to remain the principal tool for long-term green investment, its potential for providing long-term financing for innovative resource efficiency projects would be enhanced if it were involved in government-led strategic reviews of future resource productivity technologies and growing industry sectors, in order to ensure that emerging but promising technologies and sectors were not missed. This could be undertaken in tandem with the Government's proposed new Industrial Strategy.

Figure 4: *Total waste sent to final treatment (landfill vs. non-landfill) by type of waste material, 2012 (Mt).*



5. Consumer information

One of the barriers to pro-environmental or resource-efficient behaviour is the lack of information that would enable people to make such decisions. One response to this in the consumer area has been the emergence of labels and certification schemes. However, the proliferation of different consumer labelling schemes, each with slightly different criteria, may be counter-productive. As is made clear by the guidance from the Department for Environment, Food and Rural Affairs (Defra) on environmental claims and labels, a wide range of voluntary and mandatory environmental claims and labelling schemes are in operation, relating to a variety of products including food, timber, paints, aerosols, cleaning products and electrical products[23], frequently asserting different pro-environmental qualities. As noted in Chapter 9, citizens are "overwhelmed by the volume of choice and information they are exposed to, and marketer's relentless efforts to 'engage' with them"[24]. Defra's guidance states that "environmental claims and labels must be credible to consumers, clearly understood, and genuinely reflect a benefit to the environment". Defra is not responsible for enforcing the accuracy of claims in environmental labels – that lies with a range of other bodies, including local authority Trading Standards Services and the Advertising Standards Authority[23] – but there may be a role for government to step in and facilitate a more uniform certification approach, beyond the existing Defra guidance.

Regulatory approaches

In some cases, regulations may inadvertently be providing a barrier to increased resource efficiency. In such cases, the amendment and reform of regulations would increase resource efficiency.

1. Regulations for remanufacturing

One example is in the case of remanufacturing. It involves the disassembly of product components and their remanufacture into modules or products with 'as new' qualities. As a relatively new concept, the regulations concerning design, sales and disposal of products were not created with an awareness of the possibility of remanufacturing, and thus in some cases work against it. For example, materials once classified as waste may be prohibited from re-entering product supply chains. Clearly, the original framing of such regulations has important justifications, for example to avoid amplifying contaminants in the food chain, or to avoid the production of goods from materials whose safety performance has been compromised. However, such regulations mean that warranties and safety guarantees may in some cases not be achieved by remanufactured products, despite the fact they are designed to 'as new' specifications[25]. Amendments to such regulations that allow remanufactured products to achieve the same warranties as new products, provided of course that they meet the same strict safety performance criteria, would do much to improve the prospects for remanufacturing industries.

2. Extended producer responsibility

In the UK, producer responsibility legislation places a responsibility on businesses for the end-of-life environmental impact of packaging, electrical and electronic equipment (EEE), batteries and vehicles[26]. These regulations could be extended to include more businesses and products, with higher requirements. So-called extended producer responsibility (EPR) seeks to make the manufacturer responsible for the entire lifecycle of the product, especially the take-back, recycling and final disposal of the product at the end of its use-life[27]. The responsibility can be either physical or financial (as with the Packaging Recovery Note (PRN) scheme in the UK[28]) and can be undertaken individually by the original manufacturer of the product, collectively by a group of manufacturers, or by third parties. A number of EPR schemes have been introduced around the world, especially in Japan, Canada and Europe, where current EPR schemes cover packaging, batteries, electric and electronic equipment and vehicles.

EPR regulations might stimulate a number of innovative responses from producers. In leasing or service-based business models, producers sell the services from products over their lifetime, rather than the products themselves. Producers might try to incentivise consumers to return end-of-life products to them by charging a fee when the product was sold which would be returned to the consumer when the product was returned when its life was over, similar to deposit-refund schemes which are in place for drinks bottles in a number of countries. The treatment of end-of-life vehicles (ELVs) comes closest to this philosophy at the present time, as according to the EU ELVs Directive (2000/53/EC) auto-manufacturers are required to take back their ELVs and recover a minimum of 95% of their materials, with 85% being reused or recycled, and the remaining 10% able to go to energy recovery.

3. Ecodesign

Although design itself consumes only about 15% of the resources of the manufacturing processes, the European Commission estimates that more than 80% of the lifecycle environmental impact of a product is typically determined at the design stage. Ecodesign, or design for the environment (DfE), integrates environmental considerations into the design of products and processes with the aim of reducing their lifecycle environmental impacts, and this approach could make a significant impact on resource productivity. The EU Ecodesign Directive (2009/125/EC) provides

> The resource productive economy could create **wider social benefits** by redressing the structural imbalance of unemployment

Pay as you throw, Italian style

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The advocacy group Zero Waste Europe has highlighted two case studies from different regions of northern Italy. In the town of Capannori and the city of Treviso, rates of domestic waste segregation for recycling now exceed 80%. In both areas, residents segregate their recyclable waste into multiple streams. They are incentivised by pay-as-you-throw systems, which charge them according to the weight of non-recyclable waste. Incentives are also provided in both municipalities to encourage composting. Transparency and communication are considered to be crucial to the success of the schemes. In Capannori, residents were extensively consulted and provided with information prior to the introduction of the measures; and in Treviso, an online database allows residents to track what waste has been collected from them and to understand how their charges have been calculated[15, 16].

the framework for setting ecodesign standards for a range of energy-related products.

Successful regulation will also depend on the ability to measure and set standards on identifiable resource productivity indicators. For example, Environmental Product Declarations (EPDs) use lifecycle analysis to provide verifiable information of the environmental impacts of a product, including raw material extraction, energy use, air, soil and water emissions/discharges, water use and waste generation. As a development of EPDs, 'product passports' would also contain relevant information regarding the material composition of the product; its upgradeability; the replaceability of important components by users; and information on the efficient use and proper disposal of the product, such as dismantling and recycling instructions, and the toxicity of materials. This would greatly facilitate the reuse or remanufacturing of the product at the end of its use life.

4. Driving future performance, supporting commercial research and development, and scale-up

Regulation can also be an important way of driving future innovation, by providing producers with a clear signal as to what future performance requirements will be. An example of this type of approach is Japan's Top Runner scheme, which is concerned with energy efficiency and has successfully driven up design standards across a range of consumer product groups[29].

5. Food chain regulation

In the area of food waste, regulations could be developed to inhibit commercial practices that tend to generate waste. These could include preventing excessive cosmetic standards that cause large amounts of discards, and promoting 'whole crop purchasing' (see Chapter 6). The public sector could set an example in these areas through its procurement policies (as discussed under 'Green public procurement' on p183).

Strategic approaches

1. Industrial strategy: skills, training, research and development, and coordination

Chapter 10 explored the different kinds of jobs and businesses that could be generated through a transition to a more resource-productive economy. The jobs required to bring about many aspects of resource productivity may in some cases require new skills, and in other cases may build on existing skill bases from previous industries.

UK manufacturing has been declining for decades. In 1990, manufacturing contributed 19% of UK economic output; by 2014 this had fallen to 9%. Services, meanwhile, grew from 67% of output in 1990, to 80% in 2014 (ref. 2). Notwithstanding overall economic growth during this period, this kind of economic restructuring has led to uneven impacts. The regions of the country where industry and manufacturing had traditionally been strong, for example, have been amongst those worst hit by unemployment[3].

In 2011, the government published a 'Plan for Growth' which noted the decline in output and jobs in manufacturing, and stated an objective to "achieve strong, sustainable and balanced growth that is more evenly shared across the country and between industries"[30]. The document described numerous measures, including reductions in corporation tax and further tax relief to small businesses. However, in addition to such measures, constructing an industrial strategy around the aim of making the UK a leader in resource productivity could stimulate jobs and growth. Increased resource productivity could have positive employment benefits, especially in sectors currently most affected by unemployment[3]. For example, remanufacturing activities could logically be sited in areas of existing or historic manufacturing, where unemployment tends to be higher as a result of the decline in those sectors.

A Foresight report for the Government Office for Science, 'The Future of Manufacturing', identifies four key features of this future[31]. Manufacturing will be more responsive and closer to customers, with digital technologies allowing mass personalisation and distributed production. There will be new global market opportunities from emerging economies, but also potential for some 're-shoring' of UK manufacturing, as shown by the examples of several companies that have returned some or all operations to the UK, for diverse reasons including quality control, reduction of carbon footprint, and the marketing power of a 'made in Britain' brand. There will be increasing focus on the sustainability of products, both due to national and international regulations, as well as consumer-pull. All these characteristics could promote resource productivity and a more 'circular' economy in the UK – and in so doing generate medium- and high-skilled employment opportunities[3].

The report makes a number of recommendations including: the importance of developing and training a skilled workforce; the potential for 'phoenix industries' (declining industries whose skill bases can still be used to seed newly emerging industries); the significant role that government can play in assisting industries and supply chains by supporting co-location and manufacturing regions; the importance of 'patient capital' (ie financial support that is not tied to a requirement for high returns in the short term) to support long-term investment; the importance of research and development in new technologies; the value of well-designed regulation to incentivise product and process efficiency; support for new business models based on reuse, remanufacturing; and 'servitisation' models.

Existing government programmes include the Advanced Manufacturing Supply Chain Initiative, which was launched in 2012 to help facilitate potential supply chain partners to co-locate in the UK; and the High Value Manufacturing Catapult Centre[32]. Co-ordinating activities such as these should be continued and expanded.

2. Facilitating industrial symbiosis

The classic definition of industrial symbiosis is that it "engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products"[33] (see Chapter 11, case study on page 157).

Kalundborg in Denmark is considered the paradigmatic model of a geographically-specific industrial symbiosis network[34]. This concept is also at the heart of Japan's Eco-Town programme, which has led to the establishment of 26 eco-towns across the country. In the Kawasaki Eco-Town, for example, plastic is recycled for use in blast furnaces, for concrete formwork and for ammonia production; polyethylene terephthalate (PET) plastics are recycled to produce other PET products; and paper is also recycled. As well as reducing material waste, the industrial symbiosis strategy in Kawasaki has been estimated to have reduced lifecycle carbon emissions by 13.77%, mainly from iron and steel, cement and paper manufacture[35].

As a result of government subsidies, 61 recycling facilities have been established across Japan's 26 eco-towns, with a combined capacity of nearly 2 million tonnes of waste per year. And for every government-subsidised recycling plant, a further 1.5 plants were built by the private sector without subsidy[36]. This suggests that government actions to establish an industrial symbiosis ecosystem can act as a springboard for further private sector-led development of environmental industries. Industrial symbiosis is also well established in other Asian countries, including China[37–39] and Korea[40]. An alternative approach is the geographically dispersed facilitated industrial network, of which an example was the UK's National Industrial Symbiosis Programme (NISP) (see case study on page 182).

Potential future opportunities for industrial symbiosis in the UK might be identified through careful analysis of data on material resource flows through industries, including which materials are disposed of in landfill; which are used for energy recovery; and, of the materials captured for recycling, how much is recycled and reused within the UK, as opposed to exported to other countries (see Chapter 2).

3. Green public procurement

Green Public Procurement (GPP) is a process whereby public authorities seek to procure goods, services and works with the same function but a reduced environmental impact throughout their lifecycle. As just one example, a recent study estimated that the UK could save up to £40.7 million as well as reducing CO_2 emissions and waste management costs if the proposed Government Buying Standards for furniture were applied by all central government departments and executive agencies[43]. Similar cost, carbon and materials savings are likely to be available across many procurement areas.

Government procurement can also be a key tool for driving future innovation, by setting ambitious future standards. A government advisory group, the Environmental Innovation Advisory Group (EIAG), developed the concept of 'forward commitment procurement' in its first report of 2006 (ref. 44). The report argues:

"R&D is relatively cheap and leads to many prototypes but all too frequently these do not make it to market because the uncertainty of future sales makes it too risky to invest in expensive demonstration and scaling-up. Investment at this high-risk stage only makes sense in the context of a commercial opportunity that may not be visible, or attainable to a supplier without good supply chain management by those further up the value chain. The Government is uniquely placed to make this opportunity both visible and credible through its procurement activities."

The proposed process would therefore be that a public sector body would offer to buy "in the future a product or service that delivers specified performance levels including environmental benefits at a defined volume and at a cost it can afford". If the performance standards are met at the defined future year, the procurer would buy in bulk, giving the technology developer the certainty of revenue reward needed to justify investment and scale up. At around the time of this report, the EIAG was working with procurers including the HM Prison Service, London Fire and Emergency Planning Authority, the Environment Agency and local authorities, to demonstrate the approach in practice.

Case Study

The National Industrial Symbiosis Programme

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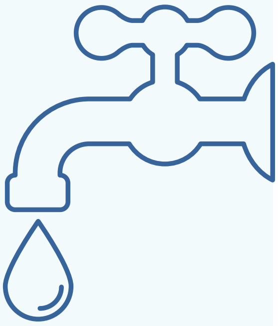
The UK's National Industrial Symbiosis Programme (NISP) was funded by Defra over five years between 2005 and 2009. The programme reduced landfill, CO_2 emissions, and the use of water and virgin materials at well below £1 per tonne; it also reduced costs and generated extra sales for businesses, saved and created jobs, and raised more than three times as much government revenue as it was given in public subsidy (see Table 1). The NISP outputs were independently verified, and take no account of any benefits from changes in business culture or awareness of resource use that are not directly related to NISP-initiated programmes.

These outcomes were the result of a sophisticated business-led (but publically facilitated and funded) programme. It combined an innovative, networked IT system; an emphasis on innovation that involved close collaboration with the relevant Knowledge Transfer Network of the Technology Strategy Board; a strategic focus and delivery plan at the regional level, at the time

Table 1: *Environmental and economic benefits from NISP in millions of tonnes (Mt) of waste and millions of pounds (£m), April 2005-March 2010. The data show that every £0.31 of government investment produced £1 of extra government revenue, a fiscal multiplier of 3.2. The 5-year total assumes NISP contribution to savings of only 60%, but persistence of savings to subsequent years, declining by 20% per year. Public investment of £27.7 million over 5 years is assumed to be split equally between 5 environmental categories (ie £5.5 million per category). Author calculation from NISP data*[41]

	Simple 5-year total	Cumulative over 5 years	Value for money (Public investment/ unit output)
Environmental benefits			
Landfill diverted (Mt)	7.0	12.6	0.44 (£/t)
CO_2 reduction (Mt)	6.0	10.8	0.51 (£/t)
Virgin materials saved (Mt)	9.7	17.5	0.32 (£/t)
Hazardous materials reduced (Mt)	0.36	0.7	7.9 (£/t)
Water saved (Mt)	9.6	17.2	0.32 (£/t)
Economic benefits			
Extra sales (£m)	176	317	0.087 (£/£)
Costs saved (£m)	156	281	0.099 (£/£)
Extra government revenue (£m)		89	0.31 (£/£)
Private investment (£m)	131		
Jobs created	3683		
Jobs saved	5087		



coordinated though the Regional Development Agencies (RDAs); and a relationship with the regulator, the Environment Agency, which not only gave access to information about the nature and location of materials that could be turned from wastes to resources, but also was extremely helpful in clarifying the relevant regulations to businesses.

It was on the basis of these sorts of insights and results that the European Resource Efficiency Platform (EREP) recommended that industrial symbiosis should be facilitated at an EU level. A recent study estimated that scaling up industrial symbiosis programmes across the EU could generate more than €3 billion in sales and cost savings, and 45 million tonnes of CO_2 reduction (5% of Europe's annual reduction target for 2020 (ref. 42)). Facilitated industrial symbiosis programmes based on the NISP model are now spreading outside Europe and are already well established in, among other countries, Brazil, China, Mexico, South Africa and Turkey.

Conclusions: Public policy for increased resource productivity

There are several strong arguments in favour of increasing resource productivity:

- Underpinning economic growth, by providing a general macroeconomic stimulus
- Job creation in industrial and manufacturing sectors
- Increased resilience to resource price volatility or possible future resource scarcity
- Cost-effective reduction of GHG emissions
- Reduction in other environmental impacts

However, markets do not necessarily achieve the full cost-effective potential of resource productivity by themselves. National-level policy has an important role to play in helping to achieve this potential. Having studied three categories of national-level policy making, we can offer the following recommendations for policies that would increase resource productivity.

1. Pricing and market-based approaches

The cost of materials and of disposing of waste, compared to the cost of the work required to use less material or create less waste, is a crucial calculus in determining to what extent resource productivity is pursued. Public policy can change the relative costs of materials, waste disposal and labour, to ensure that increased resource productivity is better aligned with economic efficiency and business profitability.

The Landfill Tax is an important environmental tax that has had a clear impact on increasing resource productivity, mainly through increasing recycling rates. However, the Landfill Tax does not directly incentivise households to reduce the quantity of waste they generate. In fact, waste collection and disposal for households continues to be financed through taxation, irrespective of the weight and volume generated by particular households. This effectively results in waste-intensive households being subsidised by those that try to reduce and recycle their waste. It is economically inefficient, unfair, and provides no encouragement or incentive for households to engage more sustainably with their waste.

The economic policy instrument that has been effectively employed by a number of countries to address this situation is to charge people for the weight or volume of waste they generate, through so-called 'Pay-As-You-Throw' (PAYT) schemes, examples of which are briefly described in the case study on page 174. The success of such schemes depends critically on their design, such as ensuring effective communication and transparency as to the reasons for the charges and the measures that can be taken by householders to reduce or avoid them. It could also be emphasised that the charges are replacing unfair and regressive taxation, rather than adding new costs. Such communications measures are likely to be critical features to support householders in adjusting their behaviour in the desired direction – thereby avoiding the charge, rather than paying more and continuing to generate waste.

Once appropriate price signals are in place, a whole range of supplementary policy instruments may be introduced as a further stimulus to waste reduction and recycling. These include composting incentives, explanations about the economic and environmental benefits of reducing landfill, and various options of re-use and repair as well as recycling, including through the use of online communication channels. Deploying these instruments alongside one another as part of a package can reduce overall waste collection and disposal costs, and make it easier to dispose of waste responsibly, thereby helping to avoid environmentally harmful disposal of waste outside proper waste pathways.

A second issue with the Landfill Tax is that it is a tax on waste disposal, and therefore does not have a direct effect on activities further up the supply chain of a product, from material extraction through manufacturing and assembly. Increased resource productivity in supply chains could be stimulated by extending the aggregates tax to cover more materials, and raising it gradually and transparently, in a similar manner to that pursued with the Landfill Tax.

The impacts of these pricing measures would be enhanced – offering greater competitive advantages from increased resource efficiency – if corresponding measures were undertaken to reduce the cost of labour, aiming as far as possible for revenue neutrality. Measures could include reductions in employer National Insurance contributions, and reductions in VAT or tax rebates on the labour costs of resource productive activities, such as the repairing of appliances.

Pro-environmental consumer choices can also be supported by well-articulated consumer information, and the government should ensure that such information is consistent, transparent and trustworthy.

The government should find ways to make patient financing available, to support resource productive investments that have a long payback time. Financing strategies should be coordinated with the government's long-term industrial strategy and technology horizon scanning, to ensure that promising but emerging technologies and sectors are not left out.

In combination, these measures would increase the costs of resource consumption and wastage, while decreasing the costs of the labour required to use resources more efficiently, and reducing investment barriers to resource-productive innovations. Overall, they would provide a strong stimulus towards resource productivity.

2. Regulatory approaches

Regulations are also important structures that influence the behaviour of firms and individuals. It is worthwhile examining regulations to ensure that they encourage, and do not obstruct, resource productivity.

Regulations surrounding waste product standards and warranties should be re-examined to ensure that they do not inhibit remanufacturing. This should not compromise safety and other standards. Regulations should reflect that it is possible to meet such standards using remanufactured components.

Producer responsibility regulations should be extended to make producers responsible for the full material lifecycle of their products. This would include ensuring that packaging was easily recyclable; that there were incentives for products to be collected at the end of their lives; and that they can be disassembled for easy repair, or for recovery and recycling of their parts.

Data from developing product passports and

EPDs would enable resource productivity targets to be set for product groups. These should be set using the Top Runner approach, with clear standards for future performance set in advance.

It may also be possible to use regulation to discourage certain wasteful commercial practices, for example the rejection of edible food at the farm gate for aesthetic reasons.

It is sometimes perceived that increasing regulations will lead directly to increased costs for businesses and consumers. This can of course be the case. However there are various potentially countervailing effects, which should also be considered.

First, it should be recalled that even if costs are increased in the short term in one particular part of the material chain, this is often simply an internalisation of an externality which had previously been paid for in some form in another part of the chain. For example, if extended producer responsibility regulations impose costs upon the producer of a product due to the requirement to reclaim end of life materials, they nonetheless avoid the costs that were previously paid by local authorities (and by extension households through council taxes) for the end of life disposal of the materials.

Second, there is evidence that, even without accounting for externalities, environmental legislation can sometimes lead directly to innovation and productivity improvement. Again, to take the example of EPR, such regulations could stimulate producers to develop more resource-light design of their products and packaging as a means of reducing their exposure to end of life recovery costs – the resource-light designs could result in reduced costs compared to the pre-regulation designs, generating a productivity benefit for the firm.

Finally, from a macroeconomic perspective, there is evidence from economy-wide modelling studies that resource efficiency measures can lead to increased economic productivity, as discussed in the introduction to this chapter.

3. Strategic approaches

To move beyond purely incremental improvements in resource productivity would require substantial reorganisation of the way materials move through the economy. This in turn requires reorganisation of infrastructure, and coordination between various actors in the public and private sector who may not necessarily have histories of collaboration. National government clearly has a strategic coordinating role to play, bringing actors together and facilitating the building of new relationships, supply chains and infrastructures.

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There is evidence from both the UK and other countries that industrial symbiosis programmes can provide significant economic and environmental gains. The government should explore the potential for a new national industrial symbiosis programme, taking relevant learning from previous versions (see case study on page 182), and applying it in the current context. There would be potential for such a programme to include material flows in the commercial and agricultural sectors, as well as industry.

Clear data should be generated on what material and waste flows are actually taking place, so that possibilities for symbiotic material flows can be identified. The government should review the need for data on material and waste flows, to en sure that potential reuse and recycling loops can be identified and capitalised on through its strategic activities.

The government has recently launched a consultation on developing an industrial strategy. This is a welcome development, and can be taken as an opportunity to consider how the medium- and long-term employment opportunities that could be generated by a more resource-productive economy, in areas such as remanufacturing and eco-design, can best be realised. Key elements of the strategy are likely to include skills training and re-training programmes to help provide the necessary work forces that will deliver a more resource-productive economy. A related research and development programme should support the development and scale up of promising new technologies that will enhance resource productivity, and the financing mechanisms to enable investments in such technologies should also be considered.

The government should also lead the way in stimulating demand for resource efficient products and supply chains, through the use of green forward commitment procurement.