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Resource Efficiency in Priority Irish Business Sectors

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Rialtas na hÉireann
Government of Ireland

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

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Advocacy: *We work with others to advocate for a clean, productive and well protected environment and for sustainable environmental behaviour.*

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- large scale industrial activities (*e.g. pharmaceutical, cement manufacturing, power plants)*;
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- the contained use and controlled release of Genetically Modified Organisms *(GMOs)*;
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- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2014–2020

Resource Efficiency in Priority Irish Business Sectors

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EPA Research Report

Prepared for the Environmental Protection Agency

by

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DISCLAIMER

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

The purpose of this desk study was to identify and examine the most important manufacturing and service sectors from environmental and economic perspectives and from the perspective of potential for improvement in resource efficiency. Chapter 1 introduces the objectives and scope of the project. Chapter 2 defines the terminology used in resource efficiency and introduces related concepts including material flow accounts, the circular economy and waste prevention. The methodology employed in identifying the most significant sectors is outlined in Chapter 3 and the key sectors identified are covered in Chapter 4.

The scope of this study was to focus on manufacturing and service sectors. Primary production (agriculture, forestry, fishing and mining sectors) was outside the scope of the project remit. Material consumption was of particular interest, with energy, water and waste, as well as economic indicators, also considered.

It proved difficult to allocate the material inputs to individual sectors in the Irish economy because data are primarily collected in financial terms (e.g. Central Statistics Office Census of Industrial Production) rather than in tonnes of raw materials purchased. However, data were also examined from other sources, such as Environmental Protection Agency (EPA) Annual Environmental Reports for individual licensed companies and national waste data from the National Waste Collection Permit Office. International indicators were also used in some cases to scale up Irish data (using, for example, employee numbers).

In addition to the data review, the project team examined the research literature from a wide variety of sources, discussed the subject with stakeholders and also utilised Clean Technology Centre (CTC) experience and data acquired over many years from several sectors in the field of research efficiency.

Factsheets have also been produced for the priority sectors identified. These primarily target decision makers involved in resource efficiency policy and programme development, although they should also be of interest to businesses within those sectors, providing them with examples of resource efficiency best practices.

Current Actions

A large body of work is currently under way in Europe to promote resource efficiency. The most significant of these initiatives are:

- Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth (2010);
- Roadmap to a Resource Efficient Europe (2011);
- Communication: For a European Industrial Renaissance (2014);
- Circular Economy Action Plan (2010).

In Ireland, the government has supported resource efficiency through the development and implementation of the EPA's National Waste Prevention Programme (NWPP). The NWPP, the first such national plan in Europe, has been running since 2004. In 2014 the EPA's *Towards a Resource Efficient Ireland* provided a strategy around the vision "living better, using less". Incorporating the NWPP, it sets out priorities for preventing waste and unnecessary consumption of materials, energy and water. A number of programmes have been targeted at specific sectors and topics under the NWPP, including Green Business, Green Healthcare, Green Hospitality, Local Authority Prevention Network, Stop Food Waste and Smart Farming.

In addition to the EPA, other government bodies have targeted resource efficiency. Bord Bia is implementing its Origin Green scheme and Bord Iascaigh Mhara has introduced the Green Seafood Programme for fishermen and fish processors. Other national agencies such as the Sustainable Energy Authority of Ireland (SEAI), Enterprise Ireland and the Industrial Development Authority (IDA) are also supporting resource efficiency-related programmes. Some of these take a sectoral approach, as organisations can learn from business peers and the issues that face companies are generally consistent, whereas others

are topic focused. In addition to assistance provided through these programmes, best practice guidance and other support materials for specific sectors have been produced by both SEAI and Enterprise Ireland.

In 2014 the EPA funded the development of a *Roadmap for a National Resource Efficiency Plan for Ireland*. This study assessed the current resource efficiency situation in Ireland and other states and recommended how, by the development of a roadmap, Ireland could improve its performance. This current project addresses a number of the recommendations made in the previous work and aims to identify the key sectors, from a resource use perspective, that need to be improved.

Priority Sectors

The project team carried out an exhaustive programme of acquiring and analysing a wide range of data on economic and environmental factors, from many different sources, both direct and indirect, during the course of this project.

Following a review of the available data, and in consultation with key stakeholders (including Ibec, Enterprise Ireland, the Department of Communications, Climate Action and Environment and the EPA), it was determined that the most consistent nomenclature to identify the relevant sectors was the two-digit division code from Statistical Classification of Economic Activities in the European Community (NACE) Rev. 2. Many of the data available, particularly from the Central Statistics Office Statbank, are in this NACE two-digit division format. However, there are few data on resource use (in tonnes) specific to the Irish manufacturing and service sectors.

Following analysis of all of the available environmental and economic parameters, the project team has identified the following six priority sectors as being the most significant to Ireland from a resource use perspective. Three are in the manufacturing sector and three are in the service sector, with construction considered a service rather than a manufacturing process:

- manufacturing sector:
  - food and beverages;
  - pharmaceuticals and chemicals;
  - non-metallic mineral products;
- service sector:
  - construction;
  - retail;
  - accommodation and food services.

Based on the research, a number of recommendations have been made. These relate to the individual sectors listed above (in the form of the factsheets) but also to resource efficiency in Ireland in general and to improved data gathering and analysis.

1 Introduction

1.1 Background

Worldwide, more than 70 billion tonnes of virgin materials are extracted annually (UNIDO, 2013). In Europe, the average annual use of material resources is approximately 16 tonnes per person (EC, 2018a). The bulk of this ends up as accumulated products and materials in the economy, with ≈37% converted into emissions or waste. Of the 8 billion tonnes used in Europe, 1.7 billion tonnes are imported and 2.6 billion tonnes ends up as waste (EC, 2018a). Fuels accounted for the majority of these imported materials. This highlights the lack of energy independence within Europe and indicates the importance, from a resource efficiency perspective, of moving towards alternative energy sources such as wind and sea.

In 2008, the Commission adopted the Raw Materials Initiative (EC, 2018b), which set out a strategy for tackling the issue of access to raw materials in the European Union (EU). This strategy has three objectives:

1. the fair and sustainable supply of raw materials from global markets;
2. the sustainable supply of raw materials within the EU;
3. resource efficiency and the supply of “secondary raw materials” through recycling.

The strategy covers all raw materials used by European industry, although it excludes materials from agricultural production and, interestingly, materials used as fuel. The focus of this study is primarily on materials, although energy sources will also be considered. Europe’s dependency on fossil fuel imports, as noted above, cannot be ignored.

In terms of material use across the EU, just four sectors account for 57% of the material inputs consumed. These sectors are:

1. construction;
2. food manufacturing;
3. agriculture, forestry and fisheries (primary production);
4. electricity, gas and water services.

Although these four sectors represent only 17% of total expenditure in economic terms, they are responsible for 42% of greenhouse gas (GHG) emissions, 52% of acidifying emissions and 37% of ground ozone precursors. Again, in terms of this current study, these sectors will be given careful consideration.

Although this study is concerned with the manufacturing and service sectors, upstream (raw material extraction/primary production) and downstream (consumption) activities in the supply chain cannot be ignored. A Wuppertal Institute study (Wilts *et al*., 2016) looking at household consumption in Germany revealed that 37% of total material requirements is attributed to the consumption of fast-moving consumer goods (FMCG). FMCG includes food, beverages, detergents, cosmetics, over-the-counter medicines and other consumables (typically high-volume/low-value goods). Of this 37%, almost 60% of FMCG-related material requirements is associated with the production of food and beverages and an additional 20% is assigned to agricultural products (Wilts *et al*., 2016).

Therefore, in terms of this study, the importance of sectors producing these fast-moving consumer goods (namely food and beverages) and the retail sector is likely to be significant and, again, worthy of detailed consideration.

1.2 EU Policy on Resource Efficiency

As long ago as 2005 the European Commission proposed strategies on the sustainable use of natural resources used in Europe (EC, 2005a) and on the prevention and recycling of waste (EC, 2011a). The objectives were to reduce the environmental impacts associated with resource use, to do so in a growing economy and to help Europe become a recycling society that seeks to avoid waste and uses waste as a resource. The EU has put resource efficiency at the top of the political agenda of Europe, including it as one of the seven Flagship Initiatives of the Europe 2020 Strategy (EC, 2010a). It is complemented by an EU Roadmap to a Resource Efficient Europe (EC,

2011b), which provides the strategic framework for future action and calls for an integrated approach across many policy areas.

Likewise, within Ireland, the Environmental Protection Agency (EPA) has launched its Waste Prevention Programme up to the year 2020, to build on the many resource efficiency initiatives already in place (EPA, 2014a).

Previous studies have shown both the value of and the potential means to achieve greater resource efficiency. The EPA-funded Clean Technology Centre (CTC) report, *Roadmap for a National Resource Efficiency Plan for Ireland* (Coakley *et al*., 2014), outlines 53 recommendations to support increased resource efficiency, including several relating to resource-efficient production. A number of these recommendations are outlined in Box 1.1. Inter alia it recommends that sectors important to Ireland be identified and that resource efficiency measures be developed for them. In order to achieve this, more specific and detailed information about the resource requirements and usage in these sectors is required. This study, in determining the main resource-consuming sectors in Ireland, attempts to address this requirement.

1.3 Scope of the Study

As this study was a follow-on from the *Roadmap for a National Resource Efficiency Plan for Ireland* (which focused on resource productivity, which is based on material consumption), it was agreed that the efficient use of materials would be the primary focus of this study. However, although materials were the main focus of this work, the consumption of energy and water was also considered important, as detailed earlier. It was made clear by the project steering group that primary production (mining, agriculture, fishing and forestry) would be outside the scope of the study. Although primary production is obviously of interest in terms of material use, the focus of this project was the manufacturing and service sectors.

This project aims to identify the most important manufacturing and service sectors in Ireland (in terms of size, value, employment and, particularly, resource use). This will be achieved primarily through using Irish data but, where appropriate, international published data will also be used. The study will also research resource efficiency metrics and benchmarks for these priority sectors.

Through this process, it is expected that improvement options, potential best practices, preferred technologies, opportunities for resource use reduction (resource efficiency) and pointers for new markets and technologies will be identified. It is also hoped that the results will help identify potential policies and strategies to promote the resource efficiency measures identified. These will be collated and reported as sectoral factsheets.

Box 1.1. Some of the key resource-efficient production recommendations from *Roadmap for a National Resource Efficiency Plan for Ireland*

Recommendations

- Suitable national target (e.g. 2% reduction in DMC per annum)
- €70 million resource efficiency fund
- €30–60 million per annum support
- Significant increase in funding for grant aid schemes
- Soft loans to businesses and organisations
- Accurate GDP/DMC data for Ireland
- Annual material flow accounts for Ireland
- National sectoral benchmarks for main sectors
- “Train the Trainers” programmes for business
- Determination of the main sectors
- Dedicated staff in local authorities focusing on resource efficiency
- Sectoral guidance and checklists
- Local authorities to undertake “light” resource efficiency assessments
- “One Stop Shop” single source of information

Source: Coakley *et al.* (2014).

DMC, domestic material consumption; GDP, gross domestic product.

2 Resource Efficiency

2.1 Definition of Resource Efficiency

Resource efficiency is essentially about doing more with less (less energy, fewer raw materials, less water and less waste). The United Nations Environment Programme defines resource efficiency as “continuously applying integrated and preventive strategies to processes, products and services. This increases efficiency and reduces risks to humans and the environment” (UNEP, 1990).

Resource efficiency is a priority action at both national and EU levels. One significant way that resource efficiency is implemented in Ireland is through the National Waste Prevention Programme (NWPP). This programme implements the annual NWPP through sub-programmes, including the Green Business, Green Healthcare, Stop Food Waste and Smart Farming initiatives. The NWPP promotes the well-known waste management hierarchy (Figure 2.1), in which waste prevention, waste minimisation and re-use (in that order of priority) are preferred to recycling, energy recovery or disposal options. By not generating waste, the need to handle, transport, treat and dispose of waste is eliminated. An associated benefit is avoiding the cost of waste management services.

Resource efficiency reflects a prevention ethos and has environmental and economic benefits as well as broader positive implications for society.

Material efficiency is closely related to the concept of resource efficiency, with the difference being that they have different system boundaries. The material efficiency concept (Rashid *et al.*, 2008) focuses on one stage of a resource’s life cycle. In contrast, the concept of resource efficiency is broader, as it regards the efficiency of a resource’s extraction, its use and the resulting environmental impacts over all life cycle stages.

2.2 Assessing Resource Efficiency

Material flow accounts (MFAs) are a method of recording the inputs of materials into and out of any system (business, geographical area or country). Economy-wide material flow accounts (EW-MFAs), which are reported annually by Ireland and all other EU countries, provide an aggregate overview, in thousands of tonnes per annum, of the material flows into and out of an economy. EW-MFAs cover solid, gaseous and liquid materials (e.g. fossil energy materials, biomass, metal ores), except for bulk flows of water and air. The general purpose of EW-MFAs is to describe the interaction of the domestic economy with the natural environment and the rest of the world economy in terms of flows of materials.

Material inputs into national economies include domestic extraction of material originating from the domestic environment and physical imports originating

Figure 2.1. EU waste management hierarchy. Source: EC (2016a).

from other economies. Material outputs from national economies include materials released to the domestic environment (e.g. emissions to air, water and soil) and physical exports to other economies. However, the material flows within the economy are not represented in EW-MFAs.

Domestic material consumption (DMC), measured directly by material flow assessments, identifies the total amount of materials directly consumed in an economy by businesses for economic production, as well as materials consumed by services and households. From a resource consumption perspective, this is a very important measurement and is used in calculating resource productivity.

Resource productivity is a measure that is used to quantify the relationship between economic activity and the consumption of natural resources. By tracking resource productivity, a country can assess whether economic activity and the consumption of natural resources go hand-in-hand (i.e. as economic activity changes, resource use changes accordingly) or the extent to which they are decoupled (i.e. as a country becomes more efficient, resource use decreases while economic activity increases). Resource productivity is calculated by dividing gross domestic product (GDP) by DMC.

However, in the *Roadmap to a Resource Efficient Europe* the European Commission recognises the limitations of using DMC in this regard. DMC captures only the material resources aspects and does not deal with other resources or the potential shift of burden across countries. Therefore, because resource productivity gives only a partial picture, the Commission recommends that it should be complemented by a "dashboard" of indicators on water, land, materials and carbon indicators that measure environmental impacts and our natural capital or ecosystems as well as seeking to take into account the global aspects of consumption (EC, 2016a). Consequently, other environmental indicators such as water and energy consumption were among the indicators considered in the determination of the significant manufacturing and service sectors in this study.

Gross national income (GNI) is an alternative indicator to GDP. GNI (OECD, 2003) is equal to GDP less primary incomes payable to non-resident units plus primary incomes receivable from non-resident units. In other words, GNI is all of the income earned by a country's residents and businesses, including that earned abroad, but it does not include income earned by foreign-owned companies located in that country.

Modified gross national income (GNI*) is a new indicator (CSO, 2017a) that was recommended by the Central Statistics Office (CSO) Economic Statistics Review Group to address challenges posed by globalisation in the measurement of national economic activity. This modified indicator gives insight into the activity within the domestic economy and is designed to be more closely related to employment growth, as it focuses on the physical capital used to produce domestic output. The indicator is designed to exclude globalisation effects that are disproportionately impacting the measurement of the size of the Irish economy and is intended to be used in place of GDP. GNI* is defined as GNI less the effects of the profits of re-domiciled companies and the depreciation of intellectual property products and aircraft leasing companies (CSO, 2017b).

2.3 Resource Efficiency at the Global, EU and National Levels

Domestic material consumption is still the main method by which resource consumption impacts are reported internationally. Figure 2.2 depicts the trend in DMC in the EU-28 between 2000 and 2016. Between 2000 and 2007 there was a steady growth in material consumption of the EU-28, with the total DMC increasing by 10%. Although imports actually grew by 23%, this trend was in line with economic growth. After 2007, during the global economic recession, a major decline occurred in DMC, decreasing year on year until 2016 (Eurostat, 2018a). The main component of this decrease was in the non-metallic minerals stream, because of the sharp decline in the construction industry.

These EU-wide trends were particularly evident in Ireland, where there was a gradual rise in DMC between 2000 and 2007 followed by a significant drop in DMC per person, from 42 tonnes in 2007 to 21.5 tonnes in 2014 (EEA, 2016) (Figure 2.3). However, this is still higher than the EU-28 average, currently estimated at 16 tonnes per person.

The main challenge for Ireland now, with the economy in a growth phase, is that the DMC does not return to the unsustainable levels of 2007, as the construction

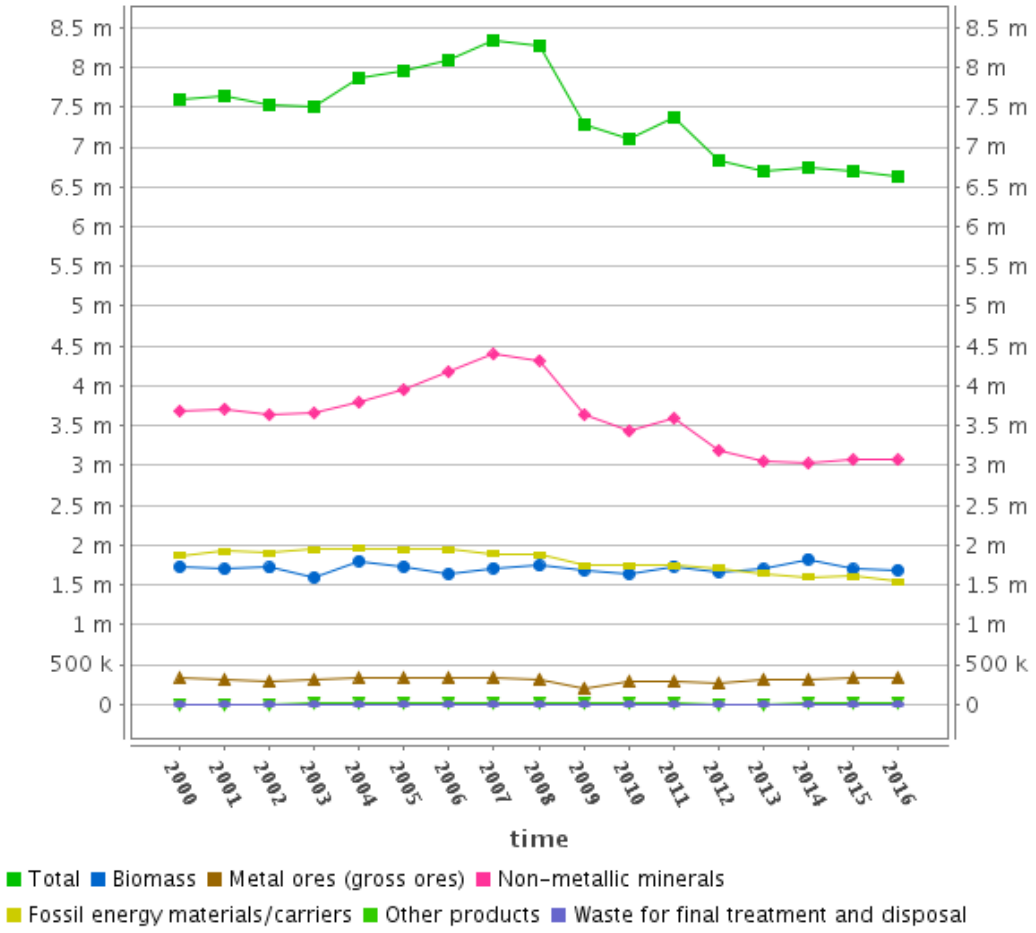

Figure 2.2. EU-28 DMC ('000 tonnes) by type of material, 2000–2016. Source: EEA (2016).

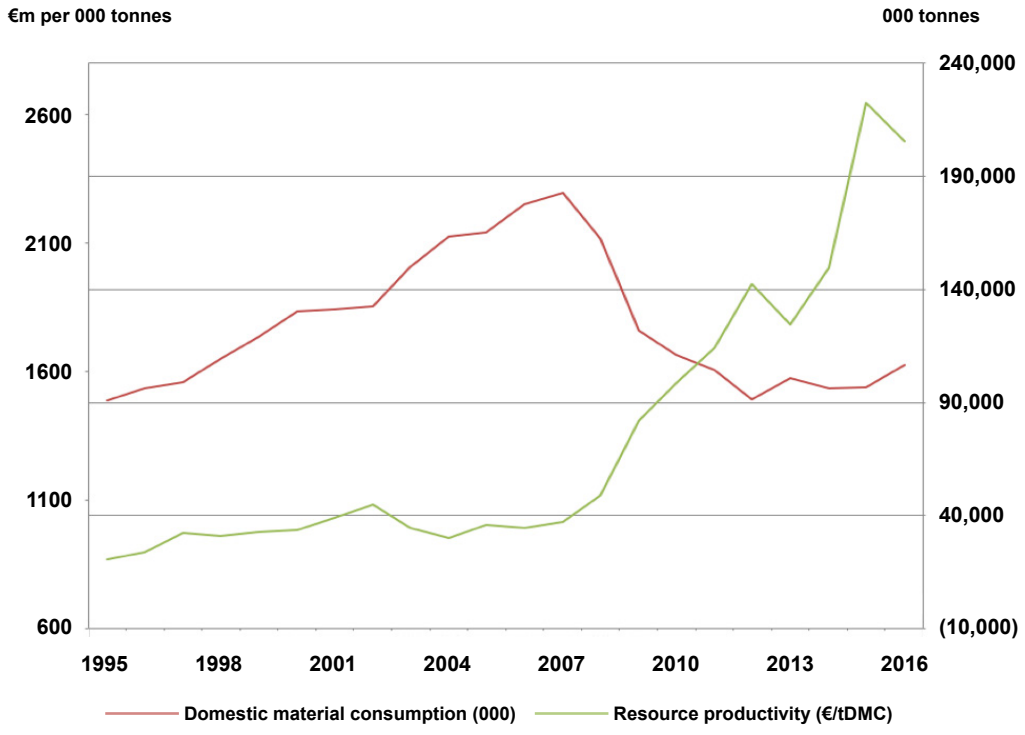

Figure 2.3. Resource productivity (left axis) and DMC (right axis) in Ireland between 1995 and 2016. Source: Eurostat (2018b).

industry continues to expand. Figure 2.4 depicts the average annual change rates in DMC and "GDP corresponding resource efficiency" in all EU states between 2000 and 2016. According to the criteria employed by Eurostat, Ireland has achieved absolute decoupling during this period. In terms of resource productivity this is reflected by the fact that, in 2016, Ireland had a value of €2.49/kg, which is almost 12% higher than the EU-28 average of €2.23/kg.

An important point worth noting regarding this profile is the 26% increase in Ireland's GDP in 2015. This increase is ascribed to "relocation to Ireland of a limited number of big economic operators" (EC, 2016b). Accordingly, there was a significant increase in GDP and this has contributed to Ireland's improved resource productivity. This, of course, does not mean that Ireland has improved its internal use of materials. Therefore, such reported national figures must be considered with care. In July 2017, the CSO released national economic activity data based on the new indicator, GNI* (CSO, 2017c). As noted previously, GNI* is designed to filter out the effects of globalisation on national statistics, specifically those related to aircraft leasing and intellectual property products. Therefore, based on 2016 prices, GDP was €275.6 billion whereas the initial estimate for GNI* was €189.2 billion.

2.4 Economic Benefit of Resource Efficiency Implementation

Previous research by the CTC estimated that, if Ireland were to achieve a 2% annual reduction in

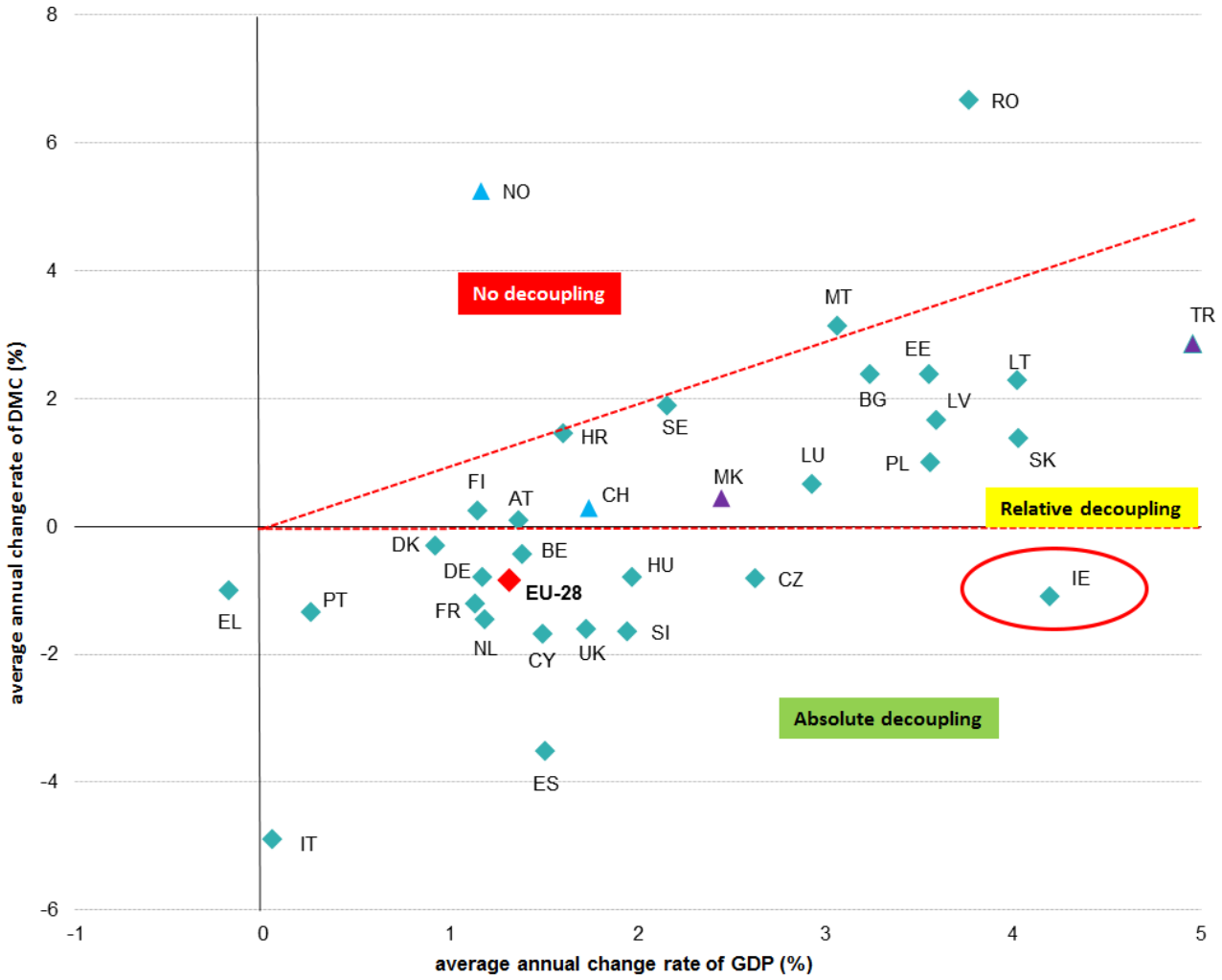

Figure 2.4. DMC and GDP: average annual change rates (%) in the EU-28 and individual countries between 2000 and 2016. Ireland (IE) is circled in red. GDP in chain-linked volumes; reference year is 2010. Norway, 2006–15; Switzerland, 2000–15; Former Yugoslav Republic of Macedonia, 2010–15; Serbia, 2001–15; Turkey, 2000–15. Source: Eurostat (2017).

DMC, while still maintaining GDP in line with growth predictions, this would yield savings of approximately €900 million in the first year and increased annual savings thereafter (Coakley *et al*., 2004). It was reported in 2013 that by 2020 this could lead to a 25% improvement in resource efficiency, yielding a total saving of approximately €7 billion over that period. Growth rates since then have exceeded predictions, meaning that savings could be even larger.

Increasing resource efficiency should therefore be seen as key to securing growth and jobs for Ireland as well as reducing our carbon footprint, limiting the environmental impact of resource use and increasing our sustainability. In order to achieve this, it is important that the most resource-intensive and economically significant sectors be identified. Once this has been achieved, targeted assistance should be provided to these sectors to ensure that they are as resource efficient as possible. This will have significant environmental and economic benefits for Ireland in both the short term and the long term.

At a micro level, resource efficiency is an economic and environmental approach for businesses to deal with the costs associated with the management of materials, energy, water and waste. Increasing the efficient use of resources will increase profitability while helping to conserve natural resources. Resource efficiency can also be used as a performance and reporting metric that distinguishes businesses that are able to create more from less. Therefore, although the environment and the economy are often seen to be in conflict, resource efficiency actually boosts business competitiveness and can also be a marketing strategy, highlighting a company's environmental credentials. This fact is clearly recognised in the Europe 2020 strategy, which highlights resource efficiency as key to securing growth and jobs for Europe.

2.5 Resource Efficiency in the Circular Economy

Although improved resource efficiency has been a primary focus of the EU since 2005, more recently the strategy has evolved towards a circular economy approach. This incorporates previous material efficiency strategies as well as "systems thinking" and use of renewable energy and, in addition, prices should reflect real costs. *Towards a Circular Economy: A Zero Waste Programme for Europe* (EC, 2014a), a Communication from the European Commission, sets out a proposed roadmap towards a circular economy. It defines a circular economy and discusses setting up a policy framework to promote resource efficiency using the circular economy approach. The focus is on waste policy and targets; the Communication discusses value chains with regard to waste prevention, waste management and support for small and medium-sized enterprises. The Communication suggests "resource productivity, as measured by GDP relative to Raw Material Consumption (RMC)" as a suitable indicator for resource efficiency.

The concept of a circular economy, incorporating material flows and resource productivity, is shown in Figure 2.5.

A study carried out for the EU in 2014, *Scoping Study to Identify Potential Circular Economy Actions, Priority Sectors, Material Flows and Value Chains,* identified priority actions and policy options that can be used to help Europe move towards a circular economy (EC, 2014b). The study identified priority sectors/products (packaging, food, electronic and electrical equipment, transport, furniture, buildings and construction) and five priority materials (agricultural products and waste, wood and paper, plastics, metals and phosphorus) to focus on with regard to a circular economy. It went on to investigate current EU legislation in favour of a circular economy as well as policies that may act as barriers and, then, with the use of a number of case studies, developed potential policy actions that may support the transition towards a circular economy.

One country that has adopted this prioritisation approach and has advanced plans in place is the Netherlands. In order to accelerate the transition to a circular economy, and improve resource productivity, the Netherlands plans to draw up "transition agendas" in which the following five chains and sectors have been given the highest priority by the Social and Economic Council of the Netherlands: biomass and food, plastics, manufacturing, construction and consumer goods. These sectors and materials were identified in the report *A Circular Economy in the Netherlands by 2050* (Dutch Government, 2016). The Dutch government is committed that by 2050 these priority chains and sectors will be using only sustainably produced, renewable or generally available raw materials and be generating as little residual waste as possible. Another Dutch objective is for products

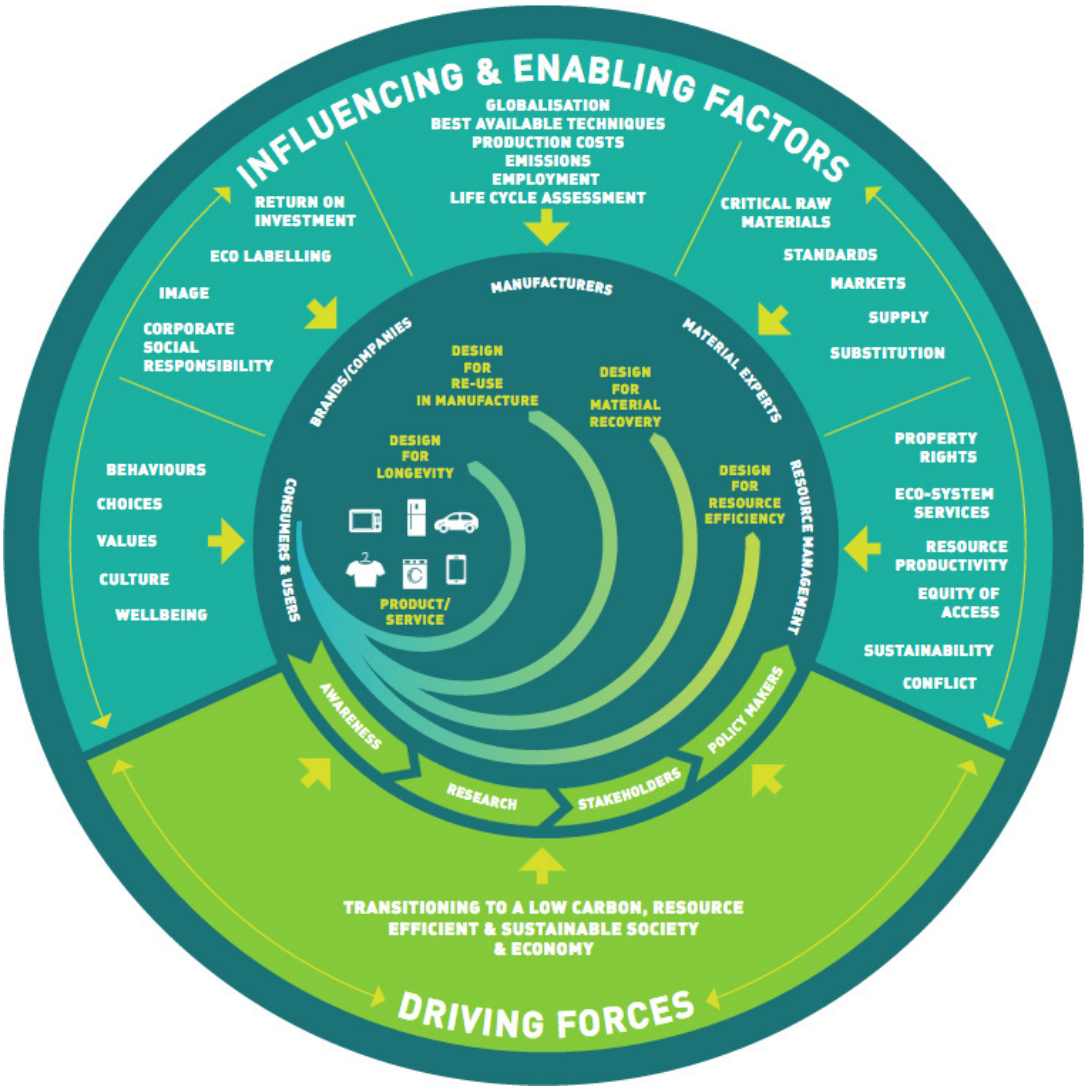

Figure 2.5. Circular economy: material flow aspects. Source: EPA (2016a).

that reach their end of life to undergo high-quality recycling and to be used to make new products. Smart return and collection systems will be set up to this end.

As noted previously, the drop in DMC since 2007 was influenced primarily by the significant decrease in mineral extraction associated with the construction sector. Now, fodder crops and grazed biomass make up the biggest share of materials consumed in Ireland (Eurostat, 2014). It remains to be seen whether or not the level of mineral extraction will increase again with the economic recovery; thus, it may be too soon to claim any long-term decoupling. In order to truly impact DMC, society (in all its elements, including manufacturing, service sectors and domestic consumption) needs to become more efficient with regard to its use of resources, leading to reduced wastes and fewer input materials used.

For Ireland to continue its current trend of increased resource productivity, and move towards a more circular economy approach, we first need to identify the priority sectors and materials. This forms the basis of this current study. The *Roadmap for a National Resource Efficiency Plan for Ireland* has outlined actions required to achieve greater resource efficiency. This prioritisation of sectors should provide focus but should also inform data issues identified.

3 Priority Sectors Selection Methodology

3.1 Overview of Methodology

The identification of priority sectors combined both qualitative and quantitative methodologies. The qualitative approach involved interviewing key stakeholders, reviewing relevant literature and calling on CTC experience with several sectors. The quantitative approach involved assessing sectors according to relevant quantifiable indicators (e.g. number of persons employed, quantity of materials purchased) and using a scoring system to determine significance. The methodology can be summarised in the following four steps:

- step 1: decide on potential sectors and indicators, following literature review and stakeholder consultation (including project steering group);
- step 2: gather data and identify information gaps;
- step 3: refine sectors (manufacturing and service) and indicators (materials, energy, water, waste, employee numbers, etc.);
- step 4: derive a matrix and populate it; rank sectors using a simple scoring system.

In advance of the project kick-off meeting a review of the literature was carried out to identify sectors and indicators used in resource efficiency. At the kick-off meeting the scope of the study was reviewed and potential key sectors were discussed, along with the main determining factors for selection. It was acknowledged that material flow data for many sectors may be difficult to identify and that other datasets would need to be used (such as waste, emissions and economic data). A lack of tonnage data for DMC grouped by sectoral Statistical Classification of Economic Activities in the European Community (NACE) code was also highlighted. It was agreed that carbon leakage and primary production were outside the scope of this study. Following the meeting the preliminary list of sectors and relevant indicators was reviewed and refined. Based on this refined list, it became quickly evident that many of the data sources were incompatible for comparison purposes, that no data or incomplete data were available for some sectors or that the available data were limited by NACE classification. This led to a further reduction in the number of sectors and indicators. Ultimately, the manufacturing and non-manufacturing sectors were assessed separately because of the limited availability of datasets (e.g. a detailed two-digit NACE division sectoral breakdown for energy consumption is currently available for manufacturing sectors only and there is no breakdown of the services sector), with many datasets available only for either manufacturing or services sectors, but not both.

The following sections outline the methodological process of steps 1, 2 and 4 in more detail.

3.2 Step 1: Literature Review to Identify Sectors and Indicators

Initially, a literature review was undertaken using the usual online sources, libraries and online databases of academic journals[1] to determine whether any similar studies have been conducted either nationally or internationally.

In total, 72 documents on the subject of resource efficiency were reviewed:

- 20 documents aimed at specific sectors;
- 32 documents giving general overviews of scoping studies regarding resource efficiency;
- 16 documents focusing solely on waste management;
- four policies or government communications.

Information on individual sectors, relevant resource efficiency materials, determining factors and indicators listed in these publications was collated. These data were used to inform the preliminary identification of sectors and indicators to be considered in the data-gathering process.

1 For example, CIT online library (https://library.cit.ie/ejournals; accessed 15 January 2019) and Google Scholar search engine (https://scholar.google.com/; accessed 15 January 2019).

Having reviewed the resource efficiency reports and guides, those in Table 3.1 were identified as being the most relevant to this work.

Of particular interest to this study was the review document *Resource Efficiency in New Zealand, an Assessment of Business Sectors*. This was developed for the New Zealand Ministry for the Environment with the aim of monitoring and reporting on the level of resource efficiency of a number of priority business sectors (New Zealand Ministry for the Environment, 2010a).

The document identified seven priority business sectors for the country including:

1. agriculture;
2. finance, insurance and business services;
3. manufacturing (excluding food and beverage);
4. food and beverage manufacturing (including agricultural products);
5. retail;
6. tourism;
7. construction.

Eight indicators (five environmental and three economic) were chosen to assess New Zealand's level of resource efficiency. These are shown in Table 3.2.

As part of this work, a matrix with all of the available New Zealand data was provided for each sector (and some subsectors), with data presented using the relevant indicators. There were significant gaps in the tabulated data. Additionally, there were too few data on water use, wastewater and solid waste and these indicators are not included in the summary report. In addition, the industry sectors that did not have data are not included in the summary table.

Following the review of international materials, a search for any Irish published sectoral documents that highlighted priority sectors was carried out. This identified 13 relevant documents, which are summarised below according to areas of focus:

- five documents focused on employment [Department of Jobs, Enterprise and Innovation (DJEI), Ibec, Solas and Forfás);
- three documents focused on growth [Enterprise Ireland and National Economic and Social Council (NESC)];
- two documents focused on up-and-coming opportunities (DJEI);
- one document focused on revenue (Irish revenue corporation tax);
- two documents did not provide criteria (CSO and Forfás).

In total, these documents identified 16 main sectors from within the manufacturing and service sectors. These, along with the frequency with which they were

Table 3.1. Documents identified as being the most relevant to this study

Report	Sectors and products	Indicators
Scoping Study to Identify Potential Circular Economy Actions, Priority Sectors, Material Flows and Value Chains (EC, 2014b)	Packaging, food, electronic and electrical, transport, furniture, buildings and construction	Carbon, materials, land, energy and water
Resource Efficiency in New Zealand, an Assessment of Business Sectors (New Zealand Ministry for the Environment, 2010a)	Agriculture, finance, insurance and business services, food and beverage, retail, tourism, buildings and construction	Water use, energy use, solid waste, GHG emissions, wastewater discharge, employee numbers, GDP, production output
Sustainable Materials Management: The Road Ahead (USEPA, 2009)	Textiles, food products and services, non-renewables, organics, metals, construction, forestry, other products and services	Energy use, material use, material waste, water use, environmental impact (13 specific indicators)
Environmental Impact of Products (EIPRO): Analysis of the Life-cycle Environmental Impacts Related to the Final Consumption of the EU-26 (EC, 2005b)	Food, clothing, housing, health, transport, communication, recreation, education, restaurants, miscellaneous	Abiotic depletion, global warming, ozone layer depletion, human toxicity, ecotoxicity, photochemical oxidation, acidification, eutrophication
Quantification of the Benefits of Resource Efficiency of the New Zealand Economy (New Zealand Ministry for the Environment, 2010b)	Agriculture, food and beverage, construction	Water use, material use, waste production, GHG emissions

Table 3.2. Resource efficiency indicators in New Zealand (2010) study

Indicators		Proposed unit
Physical indicators		
Water use	Fresh water abstracted for consumptive use from surface and groundwater sources and consented, from private and public supply schemes	m^3
Solid waste	All solid waste disposed of to disposal facilities excluding waste that is incinerated, reused, recycled, composted or exported	tonnes
Energy use	Electricity provided by the national grid, and other direct energy use from stationary sources, from the following energy sources: gas, coal, liquid fuels, biofuels, wind, hydro and solar	pJ
GHG emissions	Including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). The gases are reported under six sectors: energy; industrial processes; solvent and other product use; agriculture; land use; and land-use, land-use change and forestry (LULUCF) and waste	tonnes CO_2e
Wastewater discharges	Permitted trade waste discharges and consented discharges to land and water. Does not include storm water	m^3
Economic indicators		
Number of employees	Provides a proxy for production/service activity and for social welfare	FTE
GDP	GDP is a financial measure that reflects the contribution to the national economy	$M
Exports	For sectors where relevant data are available	$M

$M, million dollars; CO_2e, carbon dioxide equivalent; FTE, full-time equivalent (in employment); pJ, picojoules.

Table 3.3. The sectors identified in the 13 Irish reports and their frequency of reporting

Sector	Frequency
Construction	7
Food and drink	6
Financial and insurance services	6
Wholesale and retail	6
Accommodation and food services	5
Pharmachem	4
Software/information technology	4
Metal products	3
Education	3
Medical devices	2
Public sector	1
Healthcare	1
Waste management	1
Transport	1
Electronics	1
Wood, paper products and print	1

noted, are listed in Table 3.3. Although this information was considered to be non-statistically robust, it is indicative of potentially significant sectors under a limited number of criteria (employment, growth and economic value). Environmental impact and resource consumption were not factors cited in any of the reports reviewed.

3.2.1 EPA licence Annual Environmental Reports

The environmental licensing of different sectors by the EPA was considered as an indicator of potential environmental impact, thereby indicating significance. In an effort to use this data source, over 400 Annual Environmental Reports (AERs) were reviewed, on the basis that these represent some of the largest industries (not businesses) in the country. AERs for the year in question, 2014, were downloaded from the EPA database and relevant data were extracted on energy consumption (and generation on-site), water (extracted and discharged), waste (hazardous and non-hazardous) and NACE division and class(es) of integrated pollution prevention and control (IPPC) activity. Although the data were useful in comparing sector totals, for many sectors (e.g. food and beverages), IPPC companies are only a small subset of the total number of companies within that sector and, reluctantly, AER data from IPPC companies were not used in the final consideration of determination of significance.

3.2.2 EPA licensing non-compliance

Non-compliance in EPA-licensed facilities was also considered in the sense that there was potential opportunity for improvement in resource efficiency

in sectors where non-compliance was an issue, i.e. where there was significant non-compliance there was potentially significant room for improvement. Figure 3.1 shows the sectors with the most non-compliances for industrial and waste licenses in 2015. The number of non-compliances should be taken into account in the context of the number of licensed facilities in each sector (and indeed facilities with more than one non-compliance event in an operating year). For example, the food and drink sector had 81 operational EPA-licensed facilities in 2015, compared with 72 in the chemical sector and 196 in the intensive agriculture sector. The number of licence non-compliances was determined per facility per sector (Figure 3.2).

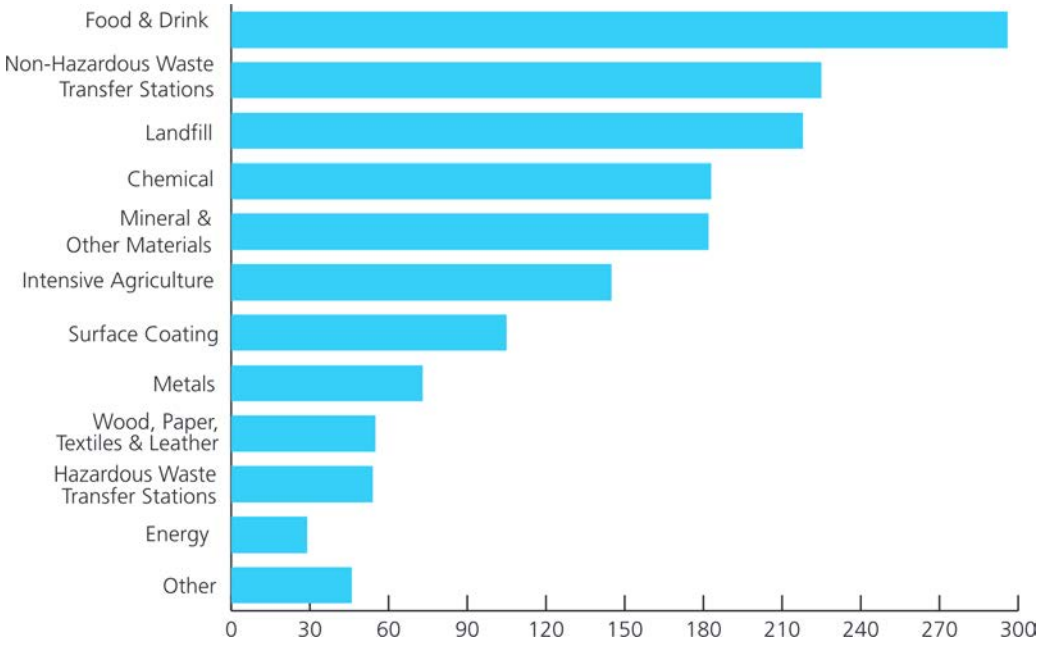

Figure 3.1. Number of non-compliances in EPA industrial and waste licensed facilities in 2015. Source: EPA (2016a).

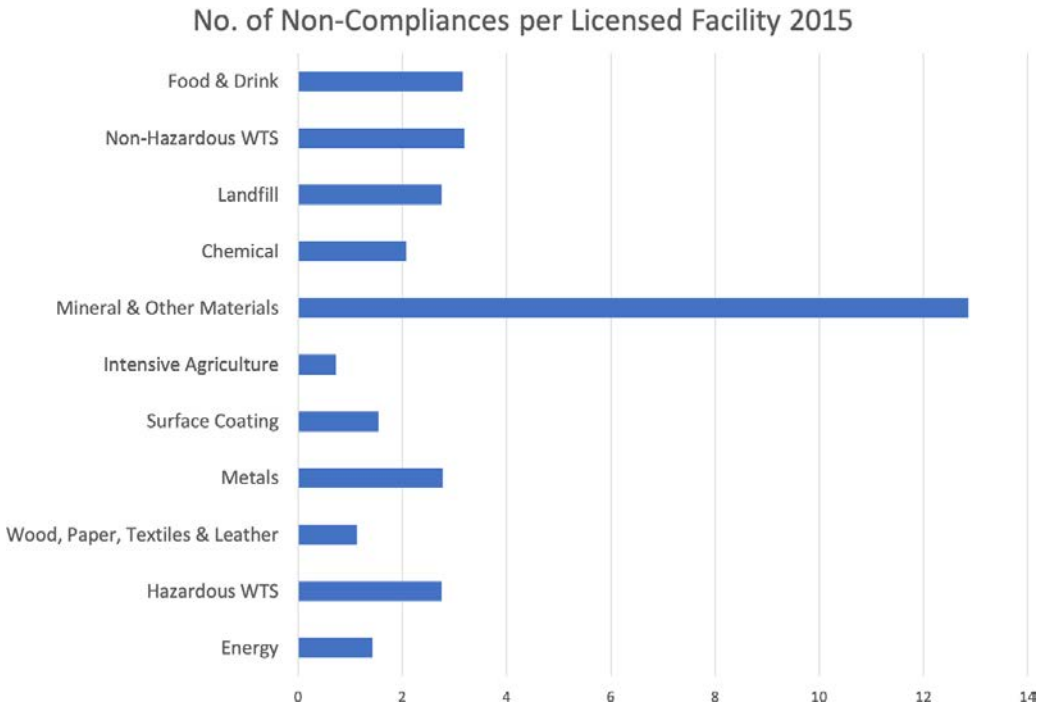

Figure 3.2. Number of non-compliances per EPA-licensed facility per sector in 2015.

This highlighted a disproportionately high number of non-compliances in the materials and other minerals licence sector. No definitive conclusions could be drawn from examination of EPA non-compliance summary data with regard to opportunities for greater resource efficiency in certain sectors.

3.2.3 Stakeholder consultation

A preliminary list of significant sectors from a national economic and environmental perspective was identified following consultation with expert representatives from the EPA, CSO, Ibec and Department of Communications, Climate Action and Environment (DCCAE):

- aviation (aircraft leasing);
- cement;
- construction;
- energy generation;
- food and drink;
- healthcare;
- information and communication technology (ICT);
- life sciences (medical technologies, engineering, plastics and pharmaceuticals);
- pharmaceuticals;
- software;
- wood processing.

Although this list was not exhaustive, nor did it follow strict NACE sector classification, it was a good starting point in terms of informing the project team of potentially significant sectors. From the initial review a preliminary list of macro indicators (sectoral level) and micro indicators (company or process level) was also identified from the literature (Table 3.4). The environmental and socio-economic indicators in Table 3.4 could be used as measures of resource efficiency.

Based on this information, and using an approach similar to that employed in the New Zealand study, the CTC developed a working matrix for collating data. The CTC encountered the same problems with data availability as that experienced in New Zealand. The lack of availability of useful data at a sectoral level is expanded on further in section 3.3.

3.3 Step 2: Matrix Methodology and Availability of Data Issues

Based on the quantitative information gathered during step 1 (literature review and assessment of national publications, EPA AERs and key stakeholder consultation), an initial matrix was developed that included a comprehensive list of sectors and indicators to assess significance with regard to material and resource flows. The aim of the matrix was to provide a structured method to allocate data and subsequently determine the priority sectors that this study would focus on. This section provides an overview of the methodology employed, the datasets

Table 3.4. Indicators and units identified

Sector	Indicator	Unit
All sectors	Quantity of materials purchased	Tonnes/annum
	Quantity and types of fuels purchased	Tonnes/annum (solid fuels), m^3/annum (gas), ktoe (oil)
	Quantity of water purchased	m^3/annum
	Quantity of waste generated (process waste, general waste, hazardous waste, food waste, etc.)	Tonnes/annum or normalise to a production parameter (e.g. kg waste/kg product)
	Quantity of packaging waste generated	Tonnes/annum
	Sales metrics (to normalise data)	Kilotonnes of product produced/annum
Industry – general	Production metrics (to normalise data)	€ sales/annum
	Energy intensity	kWh/kg product produced
	Renewable materials used/total materials	kg renewable materials/kg total materials
Construction	Amount of waste generated/100 m^2	m^3 or tonnes of waste/100 m^2 built
	Recycled/recovered materials input	kg recycled material input/kg material

ktoe, kilotonne of oil equivalent.

used and the rationale behind the development of two separate matrices for manufacturing and service sectors.

3.3.1 Indicators

It became evident after subsequent research that sectoral data could not be found for all of the indicators initially selected from step 1 and also that the manufacturing sector would have to be assessed separately from the services sector. Additional indicators were then evaluated, such as purchase of materials, and PRODCOM data on tonnages of product produced in manufacturing sectors were requested from the CSO (PRODCOM provides statistics on the production of manufactured goods). The initial indicators identified are listed in Table 3.5, with comments on data availability and suitability. These socio-economic and environmental indicators were arrived at after researching the available data sources and following consultation with key stakeholders. Indicators selected for the final manufacturing and service sector matrices are coloured green in Table 3.5.

The following provides a brief overview of some of the issues that should be noted regarding data availability (or lack thereof) and the main indicators chosen.

Table 3.5. Indicator data availability and suitability

Key indicators	Comment on data availability and suitability
Material flow	Considered too complex to track most materials through the economy; there are potential uses of individual materials in multiple sectors or too few data available in tonnes
Waste	List of Waste codes rather than NACE used to classify waste; therefore, incompatible with most other criteria in terms of assigning to sectors. Data from the National Waste Characterisation Study 2008 (EPA, 2009) were used in the services sector matrix
Energy	SEAI data available at a two-digit division level for manufacturing sectors but not for services sectors
Water	Currently, Ireland does not report sectoral breakdown of water usage to Eurostat. Data from 400 IPPCL AERs were extracted but were not used as they are limited. UK data on water use per employee in the services sectors were used
Hazardous materials	Good information from IPPCL AERs but this is only a small subset (*c.*400 companies' AERs reviewed) of the manufacturing industry
Scarcity of materials	Difficult to apply across all sectors; directly applicable to some manufacturing sectors. Scarcity not easily quantified as estimates of global reserves and rates of depletion vary (e.g. phosphorous as a nutrient, oil as an energy source)
Air emissions	Several parameters (acid gases, GHG emissions), more relevant to manufacturing sectors. GHG emissions were used as comprehensive data are available for manufacturing sectors
Wastewater	Only IPPCL sectoral data available; too limited a dataset
Purchases	Purchases include goods and services purchased by an enterprise in the services sector. The census of industrial production compiles data on purchase of materials (economic data in € rather than quantities in tonnes) for manufacturing sectors. PRODCOM data (tonnes) were deemed to be more relevant to resource consumption
GHG emissions	SEAI data available at a two-digit division level for manufacturing but not for services sectors. Factors were used to determine GHG emissions for services sectors
Export value	Data are available on a sectoral level. More applicable to manufacturing sector than services sectors. Indicator was not used as data would skew in favour of export-oriented companies
Economic value	CSO data available at a two-digit NACE division level for manufacturing and services sectors. Turnover was considered but PRODCOM data were favoured for the manufacturing sector matrix
PRODCOM sales	PRODCOM data (tonnes) were used as an indicator in the manufacturing sector matrix. As the data were available in tonnes they were used as a direct indicator of materials consumption and data were available for all manufacturing sectors
Employment	This criterion was considered significant; a breakdown to two-digit NACE division level is available from the CSO
Growth	Predicted sectoral growth is too complex and variable to assign to all sectors
Importance to country	Considered too subjective a criterion. The overall objective of the research is to determine the most significant sectors from an economic and environmental perspective

Green indicators were used in the final matrices; red indicators were not used.

IPPCL, integrated pollution prevention and control licence; SEAI, Sustainable Energy Authority of Ireland.

Material flows

Although there are no specific data on material flows at the granular level, there are data on materials purchased. Data on materials purchased in Ireland are available from the CSO in economic terms only (€'000) and are based on the Census of Industrial Production (CIP) produced by the CSO (CSO Statbank table AIA30, Industrial Enterprises by Industrial Sector, NACE Rev. 2).[2]

Materials consumed by a sector would ideally be measured in tonnes and, if these data were available, they could be used to generate an indicator of material efficiency. Although some individual materials used within certain sectors, for example milk processed in the dairy sector, can be tracked quite accurately using CSO data, many materials are used in several sectors and this approach was deemed too complex for all of the manufacturing sectors covered in this study. For example, steel may be used in construction, manufacturing of mechanical, electrical and electronic equipment and appliances, transport (cars, ships, trucks, aeroplanes, etc.) and packaging (for food and beverages, aerosols, etc.).

This indicator was not used in the final assessment of priority sectors.

Purchases

Purchases include both the value of goods and services acquired for resale and operating expenses (extracted from CSO Statbank table ANA35). These data are collected in the Annual Services Inquiry (an annual survey of enterprises in the retail, wholesale, transport, ICT, real estate, renting, business and selected personal services sectors). The budget estimates for public spending on health, education and public services were used to determine purchases and turnover in the public sector (Department of Finance, 2013). Although indicative of the level of activity in the services sectors, how and if these relate to resource and material flows cannot be determined. Therefore, these data may not be applicable in this instance and this criterion was not used in the final evaluation.

Waste data compatibility

A significant issue in the compilation of these draft matrices was the compatibility of the different data sources available. An example of this can be seen from the examination of waste quantities generated by the different sectors. National waste data are available from the National Waste Collection Permit Office (NWCPO). The data supplied to the project team were listed as European Waste Catalogue (EWC, now referred to as List of Waste) codes, as waste returns are reported in this format.

Currently, these data are not reported based on, or linked to, NACE sectors. Consequently, although the EWC data were examined, material by material, and manually assigned to the most relevant NACE division, in many instances, especially in the larger volume chapters (e.g. 15, 20), it was not possible to assign them to any one NACE division. Table 3.6 was prepared by the CTC to assign List of Waste chapters to NACE sectors.

Table 3.6. List of Waste chapters assigned to NACE divisions

List of Waste chapter (EWC)	NACE Rev. 2 division(s)	Tonnes (2014), NWCPO
01	05–09	1167
02	01–03, 10–12	362,945
03	16, 17	6432
04	13–15	272
05	19, 35	221
06	20–22	2897
07	20–22	144,812
08	Other	4820
09	Other	406
10	23, 24, 35	21,524
11	24, 25	2138
12	22, 25	26,215
13	49–53	41,350
14	Across sectors	6923
15	Across sectors	424,495
16	49–53	208,262
17	41–43	2,917,087
18	01, 86	22,561
19	36–39 plus waste from across other sectors	1,124,476
20	Across sectors	1,331,654

2 All CSO Statbank tables can be found at https://www.cso.ie/px/pxeirestat/statire/SelectTable/Omrade0.asp?Planguage=0 (accessed 15 January 2019).

Further information on waste was subsequently extracted from over 400 IPPC licence AER returns for 2014 (for hazardous and non-hazardous waste) and was also assigned to IPPC/Industrial Emissions Directive 2010/75/EU (IED) industrial sectors according to the relevant two-digit NACE codes (NACE Rev. 2). This increased the accuracy of the dataset relating to waste but, as this waste arises from only 400 licensed activities, it is too small a subset to accurately reflect waste generation in all manufacturing sectors. Consequently, because of the uncertainty regarding the allocation of waste and the incompleteness of the dataset, waste data were not used as a sectoral indicator in the final matrix for determination of significance.

3.3.2 Sectors

Following a review of data sources, and consultation with key stakeholders (including Ibec, Enterprise Ireland, DCCAE and EPA), it was determined that the most consistent nomenclature to identify the relevant sectors assessed in the matrix was the two-digit division code from NACE Rev. 2. Many of the data available, particularly from CSO Statbank, are in this NACE two-digit division format, which is detailed in Table 3.7.

Base year for review

The year 2014 was chosen at the kick-off meeting as the base year to be examined. This was the year for which the most complete set of data was available at the time of evaluation.

3.4 Step 4: Population and Ranking of the Matrix

3.4.1 Populating the matrix

Taking the preliminary indicators and sectors into consideration, a matrix was constructed that cross-referenced the main sectors in Ireland against these resource-focused criteria. A separate spreadsheet for each criterion was populated with any relevant information that was available relating to the different sectors. Indicators were broadly classed as either socio-economic indicators (e.g. number of employees,

Table 3.7. NACE Rev. 2 manufacturing sectors by two-digit division code

NACE division	Sectoral description
10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment

PRODCOM sales data) or environmental indicators (e.g. GHG emissions, waste, water, energy). It quickly became evident that information was not available, or calculable, for many of these indicators on a sectoral level. Based on data availability, the list of criteria was subsequently revised and the matrix updated accordingly.

From a review of the preliminary matrix it also became evident that the same assessment criteria could not be used for both the manufacturing and the service sectors. As a consequence of this, two separate matrices were prepared, one for the manufacturing sectors and one for the non-manufacturing sectors (i.e. services sectors including construction). Each matrix used somewhat different assessment indicators to determine the priority sectors; for example, although number of employees was used in both matrices, PRODCOM sales data in tonnes was applicable only to the manufacturing sector matrix (more information on this process is provided in sections 4.1 and 4.2).

3.4.2 Ranking the sectors

In order to prioritise the different sectors, a simple scoring and ranking system was applied to the raw data. First, the data were scored based on relative size. For example, if there were 11 sectors in the matrix and a ranking score was assigned based on the indicator “number of employees”, then the sector employing the greatest number of employees was assigned the score 11, the sector employing the second highest number of employees was given a score of 10, etc. The scores for each sector were then summed. The final prioritisation was based on this total score.

In an effort to give priority to environmental effects, alternative methods, including using weighting factors of 1.5, 2 and 3, were tested. However, as these did not influence the overall outcome in terms of the top-ranking sectors, they were not used in the final matrices (manufacturing and service sectors).

4 Priority Sector Matrices

4.1 Manufacturing Sector Matrix

The final indicators with sufficiently resilient data in terms of environmental factors were energy consumption and GHG emissions. The socio-economic factors were employment and PRODCOM sales data in tonnes. Although waste data were also available for some sectors (from NWCPO and data extracted from 400 IPPC/IED AERs), they were not complete and were not considered in the final matrix. Similarly, there is no breakdown of water usage in manufacturing sectors (data were requested from Irish Water) and, although IPPC/IED AER data were extracted, they could not be used (as not all companies within all manufacturing sectors are IPPC/IED licensed).

Therefore, for the determination of significance of industrial sectors (in NACE Rev. 2 divisions 10–33) the following criteria were used (data source in brackets):

- PRODCOM sales data (2014 tonnes, information supplied from the CSO on request);
- energy [kilotonne of oil equivalent (ktoe) from CSO Statbank table SEI01/SEAI 2014, Energy Balance report];
- employment (number of employees, 2014, CSO Statbank table AIA30);
- GHG emissions (2014 tonnes of CO_2 equivalent, CSO Statbank table EAA09).

These have been found to be the most reliable and comprehensive datasets that are publicly available, although in certain cases they are not complete (e.g. data on some sectors are withheld by the CSO for company confidentiality reasons or two or more NACE divisions are aggregated for reporting purposes). This is discussed in more detail in the following sections.

4.1.1 PRODCOM data

PRODCOM sales data were made available from the CSO following a request by the CTC. The data were presented in sales (€) as well as volume (in various units but predominantly in either kg or litres) for the manufacturing sectors of interest. Volume data (in tonnes) were used in the assessment matrix and, when the data were not already presented in this format (kg), they were converted from litres (by applying a conversion factor of 1 litre = 1 kg, assuming that all beverages, etc., have the same density as water). The volume data (tonnes) were used in the final matrix whereas the economic data were not used.

4.1.2 Energy

The energy consumption data available are from the Sustainable Energy Authority of Ireland (SEAI, 2018) energy balance for 2014. Reported in ktoe, they are aggregated for 8 of the 12 industrial sectors considered in the manufacturing matrix. Therefore, as the data for a number of sectors were reported together, the combined data were used. This led to food and beverages, NACE divisions 10 and 11, and chemicals and pharmaceuticals, NACE divisions 21 and 22, both being treated as individual sectors. Consequently, these sectors were assessed throughout the matrix as these combinations of NACE divisions.

4.1.3 Employment

For the manufacturing matrix, the data on employment records were obtained from CSO Statbank table AIA30 (2014). Sector size, as determined by number of employees, was a relevant indicator for consideration, particularly in terms of economic importance. Number of employees also forms the basis for many performance indicators (e.g. litres of water per employee per annum) and, although resource consumption is more directly related to human activity in the services sector, number of employees in manufacturing is used as an indicator of the overall significance of a sector in socio-economic terms.

4.1.4 GHG emissions

Greenhouse gas emissions [carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6)] are reported for 2014. Not all sectoral data are available for individual NACE

divisions of interest for this project or they are grouped together in groupings (for confidentiality reasons) that do not allow for direct comparison with other assessment criteria. However, this metric was used in the manufacturing sector matrix using aggregated NACE divisions to ensure a full dataset for comparison purposes.

4.2 Selection of Significant Manufacturing Sectors

The information gathered for prioritising the manufacturing sectors is shown in Table 4.1. This includes the raw data for the different indicators used, with the sectors listed in order of NACE division.

Based on the method outlined in section 3.4.2, these raw data were converted into the simple scoring values shown in Table 4.2.

Once the final data had been collated and the scoring system applied, the final ranking of the sectors was reviewed. Based on this review the priority sectors chosen are:

- food and beverages – primarily because of the significant dairy and meat processing sub-sectors;
- chemicals and pharmaceuticals – large waste generation, large amounts of hazardous waste and economically significant;
- non-metallic mineral products – ranking highest under GHG emissions as a result of cement production.

Although the combined sectors basic metals (NACE division 24) and fabricated metal products (NACE division 25) also scored highly, it was considered that there was justification for the selection of the non-metallic minerals sector because of its significant GHG emissions (the highest from any manufacturing sector) and for the selection of the chemicals and pharmaceuticals sector because it generates over 90% of all hazardous waste.

Table 4.1. Manufacturing matrix: raw data

Manufacturing matrix		Environmental indicators		Socio-economic indicators	
NACE Rev. 2 division	Manufacturing sector	Energy (ktoe) (Energy Balance; SEAI, 2014)	GHG emissions ('000 tonnes of CO_2e) (CSO Statbank table EAA09)	Number employed (2014, CSO Statbank table AIA30)	PRODCOM sales (tonnes) (CSO, 2014)
10, 11	Food and beverages	440	1201	45,364	12,203,485
13–15	Textiles and textile products	14	10	3151	29,531
16–18	Pulp, paper, publishing and printing	24	66	13,014	1,166,124
20, 21	Chemicals and pharmaceuticals	230	321	23,833	4,066,664
22	Rubber and plastic products	48	612	8205	668,582
23	Other non-metallic mineral products	378	2363	7439	15,847,880
24, 25	Basic metals and fabricated metal products	492	1462	16,272	2,356,303
28, 33	Machinery and equipment n.e.c.	30	52	17,300	22,838
26, 27	Electrical and optical equipment	248	173	20,001	386,305
29, 30	Transport equipment manufacture	23	12	3085	16,728
32	Other manufacturing	118	115	27,469	19,946

n.e.c., not elsewhere classified.

Table 4.2. Manufacturing matrix: ranking scores

Manufacturing matrix		Environmental indicators		Socio-economic indicators		Total
NACE Rev. 2 division	Manufacturing sector	Energy (ktoe) (Energy Balance; SEAI, 2014)	GHG emissions ('000 tonnes of CO_2e) (CSO Statbank table EAA09)	Number employed (2014, CSO Statbank table AIA30)	PRODCOM sales (tonnes) (CSO, 2014)	
10, 11	Food and beverages	10	9	11	10	40
20, 21	Chemicals and pharmaceuticals	7	7	9	9	32
23	Other non-metallic mineral products	9	11	3	11	34
24, 25	Basic metals and fabricated metal products	11	10	6	8	35
26, 27	Electrical and optical equipment	8	6	8	5	27
32	Other manufacturing	6	5	10	2	23
22	Rubber and plastic products	5	8	4	6	23
16–18	Pulp, paper, publishing and printing	3	4	5	7	19
28, 33	Machinery and equipment n.e.c.	4	3	7	3	17
13–15	Textiles and textile products	1	1	2	4	8
29, 30	Transport equipment manufacture	2	2	1	1	6

Priority sectors are shaded.

n.e.c., not elsewhere classified.

4.3 Services (Non-manufacturing) Sector Matrix

For the determination of significance in non-manufacturing sectors (NACE Rev. 2 divisions 45–88), the following criteria were used (data source in brackets):

- employees (full-time equivalents, based on CSO Statbank table ANA13);
- waste (factors from national and international data);
- water (factors from international data);
- energy (factors from national data);
- GHG emissions based on energy consumption (using Irish emissions factors).

The non-manufacturing sectors matrix was, in many regards, more difficult to assign data to than the manufacturing sectors matrix. There were a number of reasons for this:

- virtually no data on material flows;
- purchases reflect both goods and services;
- no sectoral breakdown (e.g. energy consumption for services sector not broken down further by relevant NACE divisions);
- international indicators reported in factors that could not be scaled up (e.g. kWh/m^2) on account of relevant data not being available for that sector, etc.;
- no breakdown of energy use within service sub-sectors.

A brief description of the sources reviewed and those selected for the service sector priority assessment is provided in the following sections:

4.3.1 Employee numbers

For those engaged in each non-manufacturing sector, the Statbank on the CSO database was used

(CSO Statbank tables ANA13, JCA02 and JCA06). Employment figures were also received from the CSO on request to fill data gaps in Statbank. In the services sector there is typically a direct correlation between resource consumption and number of employees (with the notable exception of construction).

4.3.2 Waste data

For the non-manufacturing sector matrix a series of waste factors (e.g. kg of waste per employee per annum) was developed. These were amalgamated from a number of different sources, including:

- Irish data reported in the national waste characterisation study 2008 (EPA, 2009) and NWCPO data (e.g. on construction and demolition waste);
- international factors sourced from relevant publications.

These factors were usually presented as waste generated per employee, although other factors were used for certain sectors (e.g. waste per patient bed-day for healthcare, waste per student in education, waste per bed-night in hospitality, waste per passenger for travel). These waste factors were then applied to the most recent national data (e.g. employee numbers in a given sector) to generate scaled-up waste volumes.

The CTC has updated estimated commercial waste (i.e. non-industrial) generation for 2016, based on the 2008 waste characterisation report (EPA, 2009), which clearly shows the significance of the retail (food and general retail) and accommodation and food services (hotels and restaurants) sectors (Table 4.3).

4.3.3 Water

Similarly to waste, data relating to water used within the various sectors were researched from national and international sources (Pacific Institute, 2013). Regarding sectoral water use in Ireland there is no national information available. The most comprehensive benchmark figures for water consumption were based on UK sourced data (Statista, 2018). These provided figures for employee numbers [or other factors such as number of air passengers, bus passengers (Stagecoach Group, 2003), rail passengers (First Group, 2017), patient-bed days (UK Department of Health, 2013)], which, when combined with gov.uk and Wrap UK (Wrap, 2013) information, produced indicative data in relation to total water usage in different sectors. Again, these factors were applied to the national employment statistics available from the CSO to produce indicative water use volumes for the different sectors.

Data were extracted from Green Business programme applications and other non-published information available to the CTC to produce a number of scale-up

Table 4.3. Waste generated in service sectors in 2016

Sector	Estimated waste generated (tonnes)	% of total
Food retail	126,059	22.17
Hotels	93,113	16.38
Offices (public and private)	79,863	14.05
General retail	74,505	13.10
Restaurants	60,862	11.00
Food wholesale	46,097	8.11
Community hospitals	27,448	4.83
Acute hospitals	19,607	3.45
Information and communication	14,373	2.53
Secondary education	9827	1.73
Transport	9244	1.63
Tertiary education	7554	1.33
Primary education	5423	0.94

factors. However, because of the small dataset and the significant differences from the UK data, these data were considered unreliable and were consequently discounted.

4.3.4 Energy

Unfortunately, there were too few sectoral energy data available nationally to use for all of the NACE divisions. Although a new SEAI Business Energy Use Survey was put in place in 2009, and has been running annually since, service sector data are not currently available (Energy Policy Statistical Support Unit, SEAI, 2016, personal communication).

Data presented for the transport and storage sector were based on the transport data in the SEAI energy balance report 2017 (SEAI, 2017), excluding private car and domestic aviation data. The SEAI energy balance report was also the source of energy data for public services, education and hospitals. An energy factor, based on the SEAI energy balance and relevant number of employees, was applied to the other sectors (NACE Rev. 2 divisions 55–75) for which direct data were not available.

Energy data were also compiled from EPA Green Business programme records from service sector site visit reports (unpublished data). However, this is an incomplete dataset that cannot be relied on because of the small sample size and it was not used in the final matrix.

4.3.5 GHG emissions

Although no direct data are available for GHG emissions from sub-sectors in the services sector, an emissions factor was calculated, based on SEAI's total GHG emissions data (kt CO_2) per ktoe of total primary energy supplied, and was applied to all sub-sectors.

4.4 Selection of Significant Service Sectors

The matrix developed, based on the information gathered for prioritising the service sectors, is shown in Table 4.4. The sources of the data have been discussed in the previous section.

Table 4.4. Service sector matrix: raw data

Service sector matrix		Environmental indicators				
NACE Rev. 2 division	Services sector	Numbers employed	Waste (tonnes)	Energy (ktoe)	GHG emissions (kt CO_2)	Water (tonnes)
45, 46	Wholesale	141,480	38,663	196	844	140,976
47	Retail trade (total)	256,170	204,382	249	1071	1,072,598
49–53	Transportation and storage (H)	85,831	7299	2425	10,415	No data
55, 56	Accommodation and food services activities (I)	224,207	255,771	533	2290	4,029,635
58–63	Information and communication (J)	94,437	28,492	78	337	493,031
64–68	Finance, insurance and real estate (K, L)	136,905	21,371	114	488	586,800
69–75	Professional, scientific and technical (M)	125,343	23,174	104	447	732,960
77–82	Administrative and support service (N)	185,515	24,490	154	662	1,025,604
84	Public administration and defence; compulsory social security (O)	95,475	21,505	79	340	594,600
85	Education (P)	142,300	19,947	99	426	614,000
86–88	Hospitals (Q)	232,850	38,524	164	702	6,405,435
36–39	Management and remediation activities (E)	8667	1,124,476	389	1671	No data
41–43	Construction (F)	94,783	2,917,087	120	514	2,085,401

Based on the method outlined in section 3.4.2, these data were converted into the simple scoring values shown in Table 4.5.

Once the final data had been collated, and the scoring system applied, the final ranking of the sectors was reviewed. Based on this review the priority sectors chosen are:

- accommodation and food services – large energy and water consumer and waste generator;
- retail trade – significant employer, fast-moving consumer goods have significant impact;
- construction – largest waste-generating sector, significant quantities of materials used in construction.

Retail trade, construction, healthcare, and accommodation and food were the four sectors that scored highest in the non-manufacturing sectors matrix. A significant factor influencing their position in the ranking is waste generation (based on the 2008 EPA waste characterisation study; EPA, 2009). Waste generation is directly linked to resource consumption. Construction is a significant sector worthy of consideration because of the significant quantities of materials and fuel consumed. It is also the largest waste-generating sector. Although the healthcare sector scored highly, it is already the focus of a significant resource efficiency programme, Green Healthcare, under the EPA's National Waste Prevention Plan, and it was therefore not selected as a priority sector.

4.5 Summary of Reasons for Selecting the Priority Sectors

As stated elsewhere, significant numbers of environmental and socio-economic data were identified, acquired and analysed in the selection of the six priority sectors (three manufacturing sectors and three service sectors). Although comparable data were often not available for all of the sectors and therefore could not be included in the matrix calculations, they were nevertheless considered and factored into decisions. An analysis of the hundreds of companies that the CTC has worked with, in the Green Business programme and other programmes and in a private capacity, was also undertaken.

Table 4.5. Service sector matrix: ranking scores

Service sector matrix		Environmental indicators					Total
NACE Rev. 2 division	Services sector	Numbers employed	Waste (tonnes)	Energy (ktoe)	GHG emissions (kt CO_2)	Water (tonnes)	
55, 56	Accommodation and food services activities (I)	11	11	12	12	12	58
47	Retail trade (total)	13	10	10	10	10	53
86–88	Hospitals (Q)	12	8	8	8	13	49
41–43	Construction (F)	4	13	6	6	11	40
77–82	Administrative and support service (N)	10	6	7	7	9	39
45, 46	Wholesale	8	9	9	9	3	38
36–39	Management and remediation activities (E)	1	12	11	11	1	36
49–53	Transportation and storage (H)	2	1	13	13	1	30
69–75	Professional, scientific and technical (M)	6	5	4	4	8	27
64–68	Finance, insurance and real estate (K, L)	7	3	5	5	5	25
85	Education (P)	9	2	3	3	7	24
84	Public administration and defence; compulsory social security (O)	5	4	2	2	6	19
58–63	Information and communication (J)	3	7	1	1	4	16

Priority sectors are shaded.

Furthermore, a large body of qualitative data was acquired and analysed, such as sectoral documents, as well as pan-sectoral studies and official reports. Finally, the input of the relevant stakeholders was also taken into account.

The following summarises the key factors considered in the selection of the six priority sectors.

1. Food and beverages:
    - 12.2 million tonnes produced by the food and beverages sector in 2014 (including approximately 560,000 tonnes of beef, 275,000 tonnes of pork and 58,000 tonnes of lamb, and 200,000 tonnes of butter, 215,000 tonnes of cheese and 120,000 tonnes of skimmed milk powder produced from 6.9 million tonnes of milk) – therefore, a very large material flow;
    - Food Wise 2025 plans for significant growth in the sector (*c*.50%);
    - population growth: population of Ireland expected to reach 6.7 million by 2050 (CSO forecast), with associated increased demand for fast-moving consumer goods;
    - direct link to CO_2 and other GHG emissions from cattle supplying beef and dairy processing sub-sectors (6.42 million cattle in Ireland in December 2016);
    - 65% of land in Ireland is used for agricultural purposes;
    - competing uses for materials (e.g. energy and water);
    - potential resource efficiency gains in processing;
    - environmental impact of food and beverage waste;
    - significant sector for the Irish economy (*c*.€22 billion sales per annum), employing *c*.53,000 people;
    - number of non-compliances in IPPC-licensed facilities in the food and drink sector.
2. Pharmaceutical and chemicals:
    - largest hazardous waste-producing sector (c.55,000 tonnes per annum of solvent waste exported; EPA, 2014b);
    - large-scale materials flow – over 4 million tonnes of product according to PRODCOM sales data;
    - most significant manufacturing sector from an economic perspective, with exports of over €30 billion per annum;
    - large-scale consumer of solvents and other materials with a potentially high environmental impact;
    - employs over 30,000 people;
    - licensed and controlled under IPPC/IED by the EPA.
3. Non-metallic mineral products:
    - environmental impact of the extraction of raw materials (limestone, shale, clay, gypsum, aggregates, etc.) and production of products, particularly cement;
    - very large material flow – 15 million tonnes of product according to PRODCOM sales data, by far the largest in Ireland;
    - significant energy consumption;
    - by far the highest GHG emissions of any manufacturing sector – almost double the second- and third-highest sectors.
4. Retail sector:
    - sales/turnover of c.€39 billion per annum (on purchases of €32 billion);
    - very large employer (c.250,000 employees);
    - enterprises are significant energy and water consumers and waste generators (c.200,000 tonnes/annum, particularly packaging waste);
    - potential for resource efficiency improvement – identified previously by the CTC in Green Business and other programmes;
    - low general environmental awareness levels in this sector;
    - relatively benign environmental legislation governing this sector – fewer pressures to improve.

5. Accommodation and food services:
    - large employer (c.225,000);
    - large turnover – important economically;
    - significant purchaser and supplier of food and beverages, with associated environmental impacts;
    - large generator of food waste and packaging waste;
    - significant water and energy consumer.
6. Construction:
    - significant quantities of construction materials used during the construction process;
    - significant energy use in construction by plants and machinery and in transport of materials to sites;
    - previous very large DMC in Ireland associated with the construction sector (50 tonnes per person per annum);
    - construction and demolition waste (3 million tonnes in 2011);
    - increasing output from the construction sector in Ireland (Construction Industry Federation-commissioned economic analysis forecast 9% annual growth on average for the construction industry, reaching €20 billion output by 2020; CIF, 2017);
    - resource constraints (timber, steel);
    - significant consumption of limestone, cement, sand and bitumen;
    - higher energy efficiency targets/standards for buildings in building regulations;
    - design out waste in construction; this can be employed throughout a project life cycle;
    - potential to increase recovery of construction and demolition waste for reuse;
    - competing uses for materials (metals);
    - numbers employed (*c*.190,000).

4.5.1 Factsheets

Factsheets for these six sectors have been prepared and are available separately. The factsheets describe each sector in Ireland, potential resource efficiency initiatives in each sector and examples of best practices.

5 Conclusions and Recommendations

5.1 Conclusions

Resource productivity, a measure of resource efficiency at the national level, has increased over the last 10 years. This is primarily as a consequence of the global economic downturn in 2008 and the significant decrease in construction activity, causing a substantial reduction in the extraction of non-metallic minerals. It is also important to note that other factors have also contributed. Most notable of these is the impact of the financial activities of a small number of multinational corporations in recent years on GDP (which is used in the calculation of resource productivity). However, irrespective of this, Ireland needs to maintain this trend of increased resource productivity as the economy continues to grow, by increasing our materials use efficiency.

Although the EU Raw Materials Initiative and the circular economy are evidence that policy is progressing in this field, material resource efficiency is an area that has been somewhat overshadowed by the global focus on energy, fossil fuel consumption and GHG emissions in the climate change debate. Although there is clearly a requirement for all manufacturing and services sectors in Ireland to strive for increased resource efficiency, six priority sectors have been identified here as the most significant following evaluation of socio-economic and environmental factors:

1. food and beverage sector;
2. chemicals and pharmaceuticals sector;
3. non-metallic mineral products sector;
4. accommodation and food services sector;
5. retail sector;
6. construction sector.

The above sectors were chosen based, primarily, on available data, as outlined in Chapter 4. However, there are a number of other factors that should be noted about the sectors:

- The food and beverages sector is a very significant one to the Irish economy in terms of employee numbers (53,000 in 2014) and product sales (€22.3 billion in 2014) and also to the environment in resource consumption terms. The land area of Ireland is 6.9 million hectares, of which 4.5 million hectares is used for agriculture and a further 730,000 hectares is used for forestry (Bord Bia, 2015).
- Construction and cement manufacture (non-metallic minerals) are resource-intensive sectors. Both rely on extracted non-mineral resources: limestone and gypsum in the case of cement (4.5 million tonnes of raw materials extracted in 2014) and sand, gravel and limestone in the case of the construction sector (along with the use of processed materials including cement, steel, wood, glass and asphalt).
- The Irish pharmaceutical sector is the seventh-largest exporter of pharmaceutical and medicinal products worldwide as well as being Ireland's largest producer of hazardous waste. Over 5 million tonnes of chemical and pharmaceutical products are manufactured in Ireland annually.
- Accommodation and food services (hotels, guest houses and restaurants serving both domestic customers and tourism) and retail are sectors that rely heavily on fast-moving consumer goods. Food and beverages are very significant economically to both sectors (and also have a significant environmental impact). The retail sector is also involved in the sale of other goods such as white goods, electronic equipment, furniture, clothing and footwear.

5.2 Recommendations

One of the main challenges encountered during this research project was the lack of available data in a useable form for this type of analysis. Although data were available for most of the sectors and indicators originally identified, in most instances the data were incomplete (see section 3.3) and as a result it was not possible to apply a uniform set of indicators across the board to all sectors. For example, different sets of indicators had to be applied in the examination

of the priority manufacturing and service sectors. Consequently, from the perspective of assessing and supporting resource efficiency on a continual basis, the following provides a series of general recommendations for Ireland.

5.2.1 National data

- The CSO should continue to produce national MFAs.
- The CSO should be given resources to also attempt to produce MFAs and resource efficiency metrics for the key sectors noted.
- Resource productivity using GNI*, in addition to the existing use of GDP, should be employed and compared with EU-wide data.
- The CIP requires revision to include questions on quantity (as well as cost) of materials (water and energy) purchased for use. This information would be treated confidentially at the sub-NACE two-digit division level but would be aggregated at a sectoral level for resource efficiency determination.
- Economic data in CSO “supply and use” tables could be modelled to determine use and throughput of materials at the sectoral level. This method has been applied in other European countries.

5.2.2 Priority sectors

- All of the priority sectors should be encouraged to start tracking and producing/publishing resource efficiency metrics. This could be facilitated through existing programmes such as Origin Green, through which companies are already tracking energy, water and waste per unit of production; these could be extended to include material efficiency metrics. The production of such metrics could be carried out at a company or sectoral level. These data could be used in the preparation of sector-specific plans with material use reduction and resource efficiency targets, using key metrics.
- The material intensity of the priority sectors requires a full material flow assessment in support of further detailed analysis and subsequent policy recommendations.
- An extensive environmental input/output analysis based on real data should be carried out to determine the life cycle impacts of resource consumption in the selected sectors.
- Assistance should be provided to specific sectors to improve material efficiency. This could be supported through existing programmes such as the National Waste Prevention Plan.
- Energy efficiency improvement has direct and indirect material consumption reduction impacts. Increasing the share of renewables in electricity generation will result in a reduction in fossil fuel consumption (reducing DMC).

5.2.3 Capacity building and business support

- Although resource efficiency is used to measure national performance, it is equally applicable at the business and sectoral levels. In a business context, resource efficiency is really about reducing environmental impact while also cutting costs through increasing yield and/or reducing waste. There are a number of general approaches to reduce material intensity and associated emissions at this level. These, and other sector-specific recommendations, are outlined in more detail in the factsheets and include:
  - material substitution/selection (embodied energy considerations);
  - increased recovery for reuse;
  - low-carbon electricity use;
  - improved yield in manufacturing;
  - dematerialisation (replacing products with services);
  - product light-weighting;
  - avoidance or minimisation of use of critical materials.
- Technical support– initial capacity building of resource efficiency expertise in governmental support agencies on understanding and using the tools and approaches outlined above. It is anticipated that these resource efficiency experts will then provide guidance and assistance in the implementation of targeted sectoral improvement programmes to individual business enterprises.

- Funding (e.g. low-cost loans and/or grant aid) should be made available to companies, especially in the designated priority sectors, to enact resource efficiency improvement measures in their production processes. This would be similar to measures such as the SEAI energy efficiency improvement programmes, but directed towards resource efficiency and targeted at the individual priority sectors.

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Abbreviations

AER	Annual Environmental Report
CIP	Census of Industrial Production
CO_2e	Carbon dioxide equivalent
CSO	Central Statistics Office
CTC	Clean Technology Centre
DCCAE	Department of Communications, Climate Action and Environment
DJEI	Department of Jobs, Enterprise and Innovation
DMC	Domestic material consumption
EPA	Environmental Protection Agency
EU	European Union
EWC	European Waste Catalogue
EW-MFA	Economy-wide material flow account
FMCG	Fast-moving consumer goods
GDP	Gross domestic product
GHG	Greenhouse gas emission
GNI	Gross national income
GNI*	Modified gross national income
ICT	Information and communication technology
IED	Industrial Emissions Directive
IPPC	Integrated pollution prevention and control
ktoe	Kilotonne of oil equivalent
MFA	Material flow account
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical Classification of Economic Activities in the European Community)
NWCPO	National Waste Collection Permit Office
NWPP	National Waste Prevention Programme
SEAI	Sustainable Energy Authority of Ireland

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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Resource Efficiency in Priority Irish Business Sectors

Authors: Colman McCarthy, Safaa Al Tameemi,
Colum Gibson, Tadhg Coackley and Dermot Cunningham

Identifying Pressures

Resource efficiency is a priority action at both national and European Union (EU) level. Of the 8 billion tonnes of materials used in Europe annually, 1.7 billion tonnes are imported and 2.6 billion tonnes end up as waste. Fuels accounted for the majority of these imported materials. This highlights the lack of energy independence within Europe and indicates the importance, from a resource efficiency perspective, of moving towards alternative/renewable energy sources. In 2008, the European Commission adopted the Raw Materials Initiative, which set out a strategy for tackling the issue of access to raw materials in the EU. This strategy addresses the fair and sustainable supply of raw materials, as well as supply of "secondary raw materials" through recycling. Although improved resource efficiency has been a primary focus of the EU since 2005, more recently the strategy has evolved towards a circular economy approach. This incorporates previous material efficiency strategies as well as "systems thinking" and use of renewable energy and establishes that prices should reflect real costs.

Developing Solutions

If Ireland were to achieve a 2% reduction in domestic material consumption per annum, while still maintaining GDP in line with growth predictions, this would yield savings of approximately €900 million in the first year, with increased annual savings thereafter. Following analysis of all of the available environmental and economic parameters, the project team has identified six priority manufacturing and services sectors as being the most significant to Ireland from a resource use perspective. Three are manufacturing sectors (food and beverages, pharmaceuticals and chemicals and non-metallic mineral products) and three are services sectors (construction, retail and accommodation and food services), with construction considered a service rather than a manufacturing process. Based on the research, a number of recommendations have been made. These relate initially to the individual sectors listed above (in the form of factsheets) but also to resource efficiency in Ireland in general and to improved data gathering and analysis.

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