Chapter 10

Environment and Industry

Environment and Industry

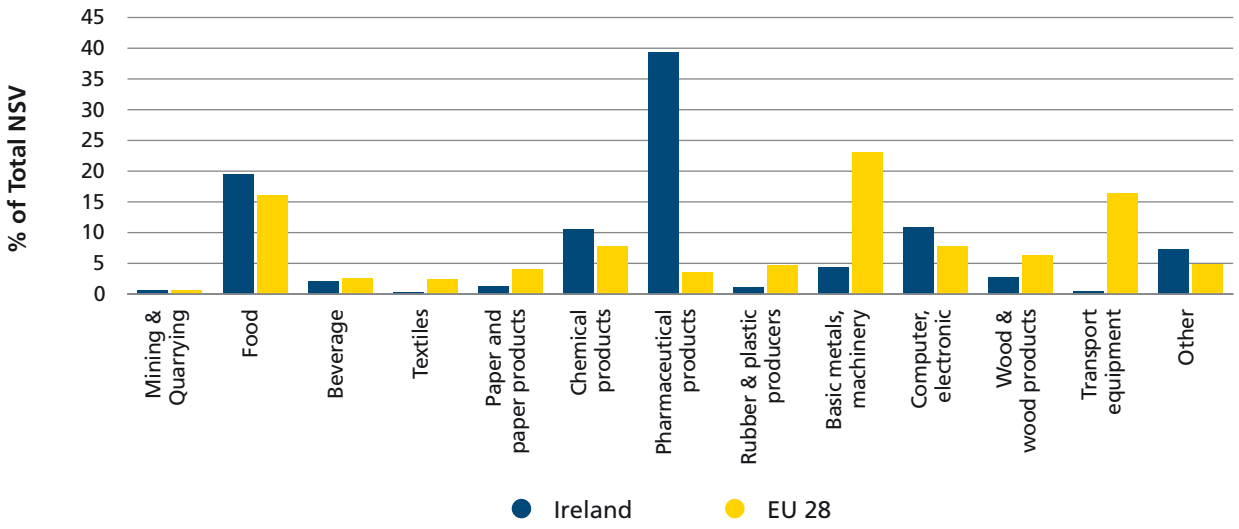
1. Introduction

Industrial activities play an important role in the economic wellbeing of Ireland. Industrial activities contribute to sustainable growth where there are effective environmental management systems in place to ensure that long-term growth does not lead to environmental pollution or the overuse of non-renewable resources.

The Industrial Emissions Directive, 2010/75/EU (IED), is the primary instrument in place to control and mitigate the environmental and human health impacts arising from industrial emissions in Ireland and across the EU. It replaced seven previous directives including the Integrated Pollution Prevention and Control Directive (IPPC). Across 65 industrial activity types listed in the IED, an operator requires a licence to carry out the industrial activity. The Environmental Protection Agency (EPA) is the competent licensing authority in Ireland for the IED[1] (Topic Box 10.1).

The profile of industries in Ireland is quite different from that across Europe. In terms of net selling value (NSV),[2] in Ireland the four largest sectors – pharmaceutical products (39%), food (19%), computers, electronic, optical and electrical equipment (11%) and chemicals (11%) (Figure 10.1) – accounted for 80.2 per cent or €97.4 billion of total NSV in 2018 (CSO, 2019). In contrast, across the EU-28 countries as a whole, the pharmaceutical sector accounted for only 3.5 per cent of total NSV in 2017. Another difference is that NSV for the EU-28 is more evenly spread over a larger number of industrial sectors. The most dominant sectors in the EU-28 in 2017 were basic metals (23%), food products (16%) and transport equipment (16%) (CSO, 2019).

Figure 10.1 Sectoral composition of Net Selling Value (NSV) in Ireland and the EU-28 (Source: CSO, 2019)



1 *The EPA is also the competent authority for the industrial pollution control (IPC) licensing regime in Ireland. This covers specified industries such as mining, peat extraction, certain food and drink activities and other specified industrial activities listed in the First Schedule to the EPA Act.*

2 *Net selling value means, in relation to a commodity or service that is sold by a person or undertaking, the amount received by the person or undertaking in respect of such sale, less value added tax (VAT). The classification of industrial activities is the Eurostat Statistical Classification of Economic Activities in the European Community (NACE) Rev. 2 classification at two digits.*

Topic Box 10.1 Industrial Licensing Process – Public Participation

Before the EPA can decide on a licence application, the Agency must carry out a thorough assessment of the application. This includes, in many cases, an environmental impact assessment (EIA) as required under the EIA Directive, and an appropriate assessment as required under the Habitats Directive. The assessment process is multidisciplinary, involving specialists from different environmental areas such as noise, air emissions, and so forth. Prediction modelling is also undertaken to determine local environmental impacts. Public participation and consultation with statutory consultees are central elements of the EPA licence assessment process. If deemed appropriate, an IED licence may be issued with conditions to prevent, reduce and eliminate emissions into air, water and soil as far as possible. The IED promotes the use of techniques that reduce pollutant emissions and that are energy and resource efficient.

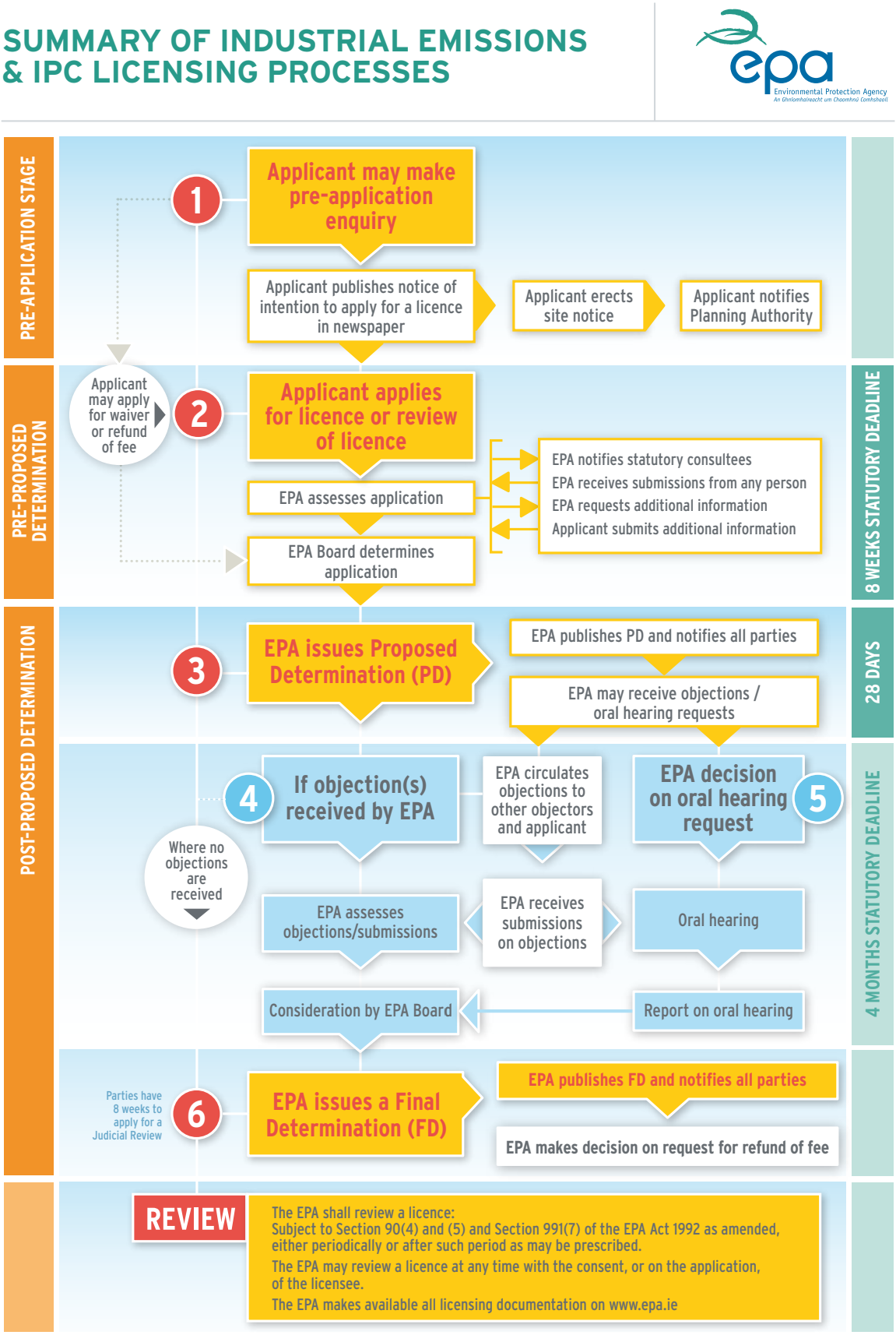
The Industrial Emissions Directive ensures that the public has a right to participate in the decision-making process and be informed of its decisions and assessments by having access to licence applications, licences and the results of the monitoring of releases. On the EPA's website[3] each installation has a homepage from where key information can be viewed, such as the licence application, licence(s), correspondence regarding the licence application and inspection, and other enforcement reports (see Figure 10.2 for a flowchart of the licensing process).

The European Environmental Bureau – the largest network of citizens' environmental organisations in Europe – examined how effectively European countries are making information about industrial pollution available to the public online, and identified the EPA website as best practice (EEB, 2017).

Continuous emission-monitoring systems can sometimes be used for monitoring important pollutants or processes. Continuous monitoring information has been made available to regulators and the public in a small number of European countries. In Ireland, boiler furnace temperature data from a licensed hazardous waste incinerator are published on the licensee's website in real time, and half-hourly averaged emissions are published 1 day delayed (Dublin Waste to Energy Ltd, 2020).

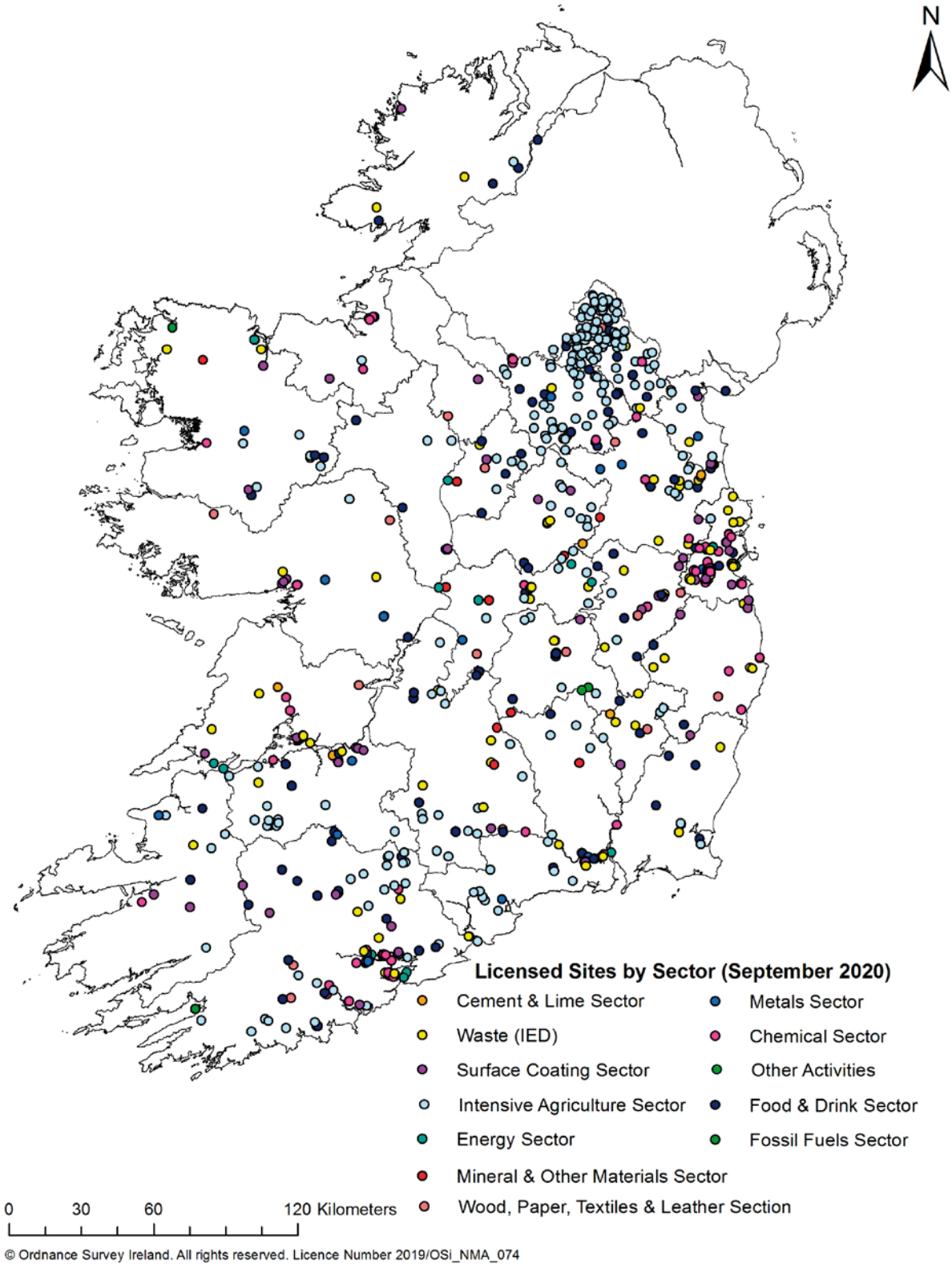
3 http://www.epa.ie/licensing/

Figure 10.2 Flowchart of the licensing process (Source: EPA)



Across Europe, the IED regulates around 50,000 of the largest industrial installations, covering a wide range of sectors. Installations include power plants, cement, lime, chemicals, food and drink, waste treatment, incineration and the intensive rearing of pigs and poultry. There are over 800 active installations in Ireland. The key sectors licensed by the EPA are illustrated in Figure 10.3.

Figure 10.3 Breakdown of active EPA licences per industry sector – September 2020 (Source: EPA)



Next to the IED, which focuses on the control of pollution at the source (i.e. at industrial installations), there are a number of additional pieces of environmental legislation at the European level that address industrial activities. These include legislation setting overall emission limits, those requiring reporting of emissions and waste generated, and those stipulating better environmental quality, reducing emissions and controlling pollution (e.g. National Emission Ceilings Directive, EU Emissions Trading Scheme, European Pollutant Release and Transfer Register Regulations, Water Framework Directive, Environmental Liability Directive and Waste Statistics Regulations). These are addressed in other chapters of this report. Topic Box 10.2 explains the development and adoption of best available techniques (BAT) conclusions.

Topic Box 10.2 Best Available Techniques

To ensure a consistent approach across EU Member States, licence/permit conditions are based on the use of best available techniques (BAT). BAT standards (known as BAT conclusions) are prepared by a technical working group of the Joint Research Centre of the European Commission, Member States, industry and civil society and are then legally adopted in the Official Journal of the EU. To date, there have been 16 sectoral BAT conclusions produced including those for power plants, chemical industry, intensive agriculture, food and drink, waste treatment and waste incineration (European IPPC Bureau, 2020). When a new BAT conclusion is adopted all licence/permit conditions for existing installations falling under the main activity of the relevant BAT conclusion have to be reconsidered and, if necessary, updated to ensure compliance within 4 years.

Following licence/permit updates, plant operators are then legally required to meet emission levels specified in the BAT conclusions, unless a detailed derogation request based on costs and benefits is received, assessed and formally granted. In Ireland, this process is regulated by the EPA.

Benefits from the Environmental Regulation of Industry

Environmental regulation of industry contributes a large dividend in terms of environmental and human health improvements.

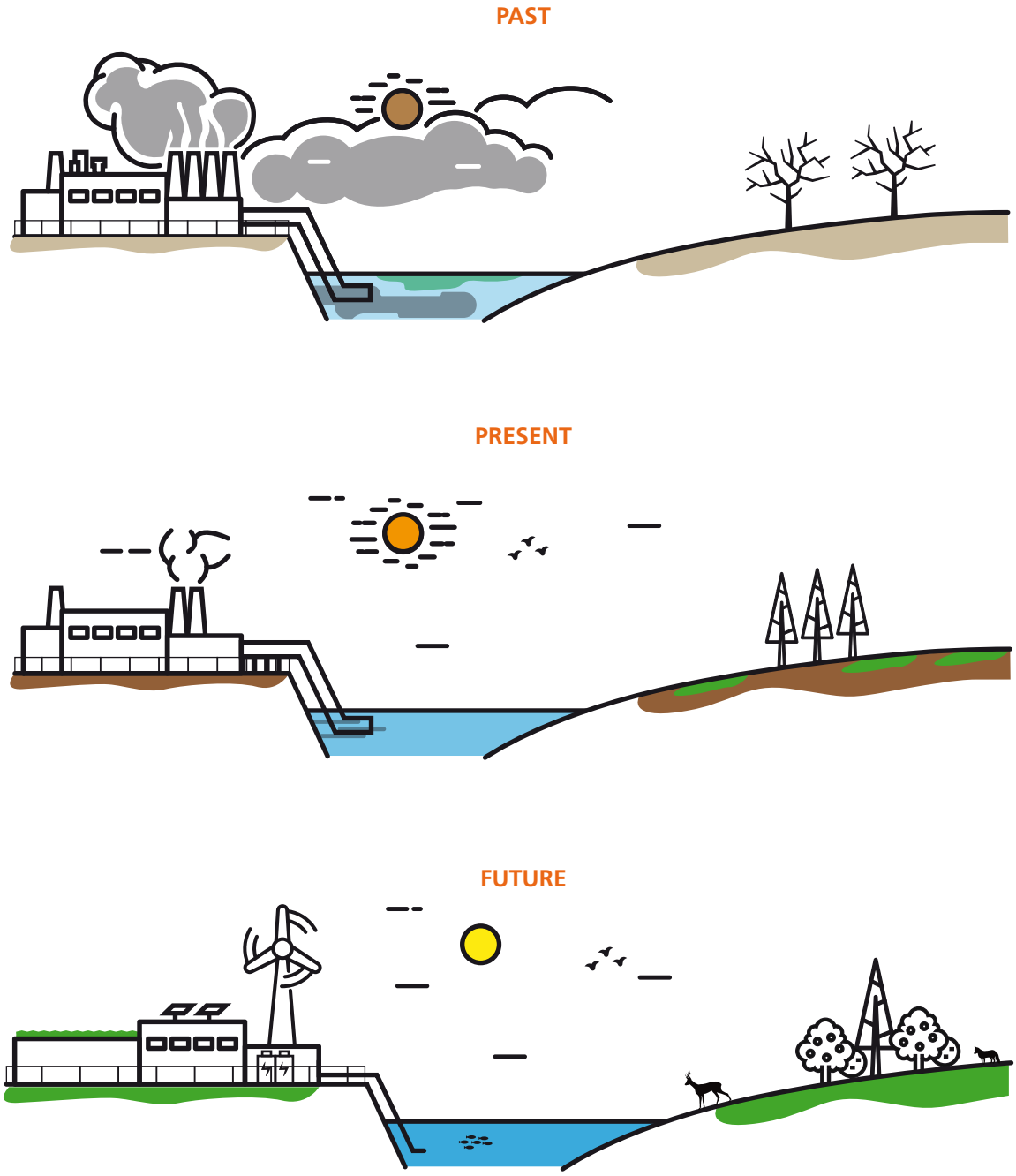
Although environmental regulation is sometimes perceived as a threat to competitiveness, it often contributes a large dividend in terms of environmental and human health improvements (Figure 10.4). The cost of not implementing current EU environmental legislation (industrial, air quality, water framework, etc.) is broadly estimated at €55 billion across the EU. This cost relates not only to environmental impacts but also to human health impacts, as a result of breaches of air quality standards, for example (COWI/Eunomia, 2019). In addition, international and Irish evidence indicates that environmental regulations incentivise firms to introduce innovations with environmental benefits that could raise revenue and reduce production costs (Siedschlag *et al.*, 2019).

Pioneering research undertaken by a Trinity College Dublin research team looking at the impact of the IPPC Directive (the precursor of the IED) on the Irish environment identified that there were aggregate pollution reductions in Ireland over a 7-year period of 22 per cent for the chemical sector, 28 per cent for the food and drink sector, 40 per cent for the pharmaceutical sector and 45 per cent for the power generation sector (Styles and Jones, 2010).

The rest of this chapter is structured as follows.

- emissions from licensed facilities
- resource use in industrial sectors
- waste generated by industrial sectors
- circular economy for resource use and waste
- enforcement of EPA licences for industrial facilities
- policy measures for Ireland's transition to a more sustainable and climate-neutral industry
- research on industry and the environment.

Figure 10.4 Impact of Industry on the environment in the past, present and future (Source: EPA)



2. Emissions from Licensed Facilities

Emissions to Water from Industrial Facilities

Industrial pollutant releases to water can have an impact on surface water quality. Industrial wastewater discharges can be directly to water or indirectly to water via sewers, with Irish Water's consent, for treatment in an EPA-licensed municipal wastewater treatment plant.

Industrial pollutant releases to water include compounds that contain nutrients such as nitrogen (referred to as total nitrogen) and phosphorus (total phosphorus), which can cause eutrophication. Releases are also described in terms of their total organic carbon (TOC) content. High levels of organic content in a natural water body will undermine an ecosystem's operation, for example by affecting oxygen levels in the water. Other relevant pollutants are heavy metals such as arsenic, copper, nickel and zinc, which can also have detrimental impacts on human and environmental health. Emerging and trace pollutants such as persistent pharmaceutical products, microplastics, trace organics and residues present a potentially serious threat from industry to human health and ecosystems, and are not commonly monitored in the environment.

Industrial pollutant releases to water can have an impact on surface water quality although the impact is determined by the characteristics of the water body and, thus, how susceptible it is to the effects of pollution. In Ireland, the overall emissions from industry to waters are relatively small in comparison with those from urban wastewater treatment plants. Total direct industrial emissions to water of total nitrogen, total phosphorus, total organic carbon and heavy metals represent less than 3 per cent of the total emissions from urban wastewater treatment plants in Ireland.

Figure 10.5 describes the releases to water from industry (directly to water and indirectly via the sewer/urban wastewater treatment plants) and, for comparison purposes, directly from urban wastewater treatment plants in the period 2007-2017. Direct releases from industry have been proportionately small in this period except for the emissions of metals. There has been a significant decrease in emissions of metals to water from industry in the past 5 years, which mirrored the implementation period for the environmental objective licence reviews undertaken by the EPA (Figure 10.6). The largest improvements were from the mining sector. The cessation of operations at one installation resulted in large environmental improvements, although other sites met the reduced metal limits in their licences through a combination of improved water management practices including reducing flows, segregation of uncontaminated waters and introducing abatement measures.

However, in recent work carried out to identify significant pressures on water bodies, the EPA has identified 34 EPA-licensed facilities (30 industrial and 4 waste) as exerting a significant pressure on waters, with five of these facilities (all food and drink) assessed to be the primary causes of pressure on nearby watercourses (Source EPA Water Programme). In addition, there are 27 EPA-licensed facilities on the provisional list of waste and industrial sites that cause/exert significant groundwater pressures. Nine of these sites are from the waste sector, eight are from the chemical sector and four are surface-coating facilities.

As outlined in Topic Box 10.1 above, under the IED regime, a host of new BAT conclusions have been or will be published, with each coming into effect within a 4-year window. This effectively means that mandatory emission limits for industrial activities, including power plants and chemical and food and drink sites, will be lowered further overall between now and 2030.

Indirect water emissions from industry (to sewers and urban wastewater treatment plants) are those that undergo further treatment in a downstream wastewater treatment plant prior to discharge to receiving waters. These indirect emissions are predominantly from the food and drink sector (50%) and the chemical sector (31%). In terms of organic content (TOC), indirect emissions have almost doubled in the past 5 years (Figure 10.7) and this is largely due to the expansion of the food and drink sectors. These emissions are putting pressure on the wastewater treatment infrastructure, which was noted in a recent European report as being uniquely already over capacity (EEA, 2019a). The recent EPA publication describes in greater detail the urgency of the need to upgrade our wastewater infrastructure (EPA, 2019). Even state-of-the-art municipal wastewater treatment facilities may have difficulty removing persistent and trace organics, and it is preferable that these wastewaters are treated at the source of generation prior to discharge to sewers.

There were a small number of unauthorised industrial releases (chlorinated substances) to sewers in 2007-2010 due to failed bunding and leakage issues, which accounted for almost 90 per cent of the indirect industrial emissions over that whole period. (Figure 10.5)

In summary, industrial emissions to water represent a small proportion of overall emissions to water that are routinely monitored. However, current policies do not address the full scope of the industrial pollution load to the environment, and greater focus needs to be placed on the fate of emerging and trace pollutants discharging from industry (Figure 10.4).

Figure 10.5 Total reported releases from industry (direct/indirect) to water and urban wastewater releases to water in the period 2007-2017 (Source: EPA http://www.epa.ie/enforcement/prtr/)

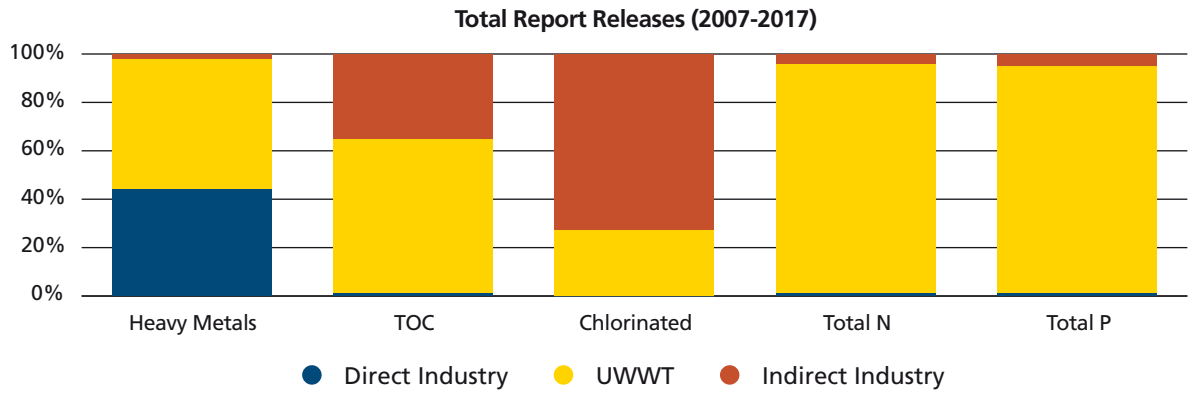


Figure 10.6 Total reported releases of heavy metals from industry direct to water in the period 2007-2017. During this time the EPA initiated 87 reviews of licences to ensure compliance with Surface Water Regulations (Source: EPA http://www.epa.ie/enforcement/prtr/)

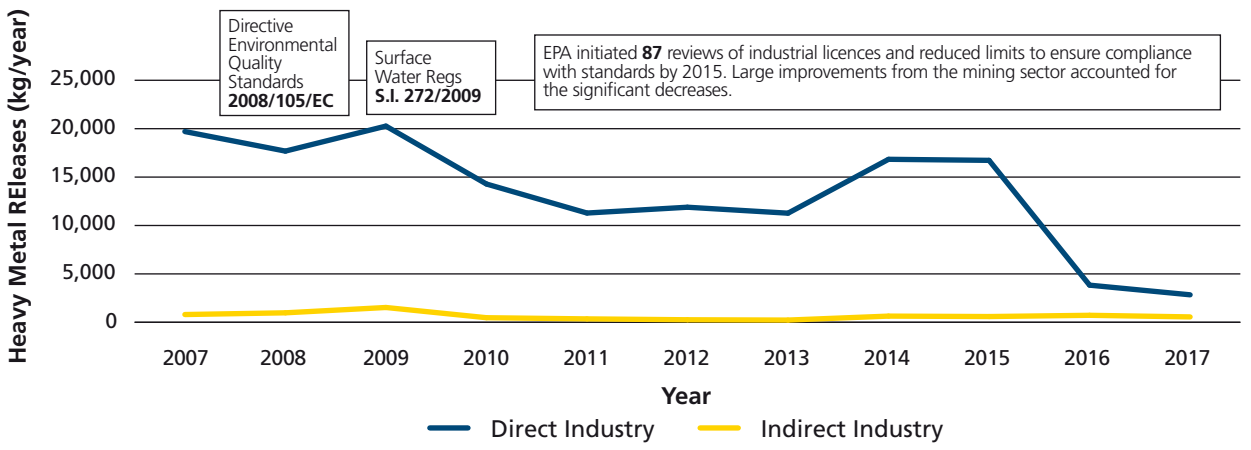
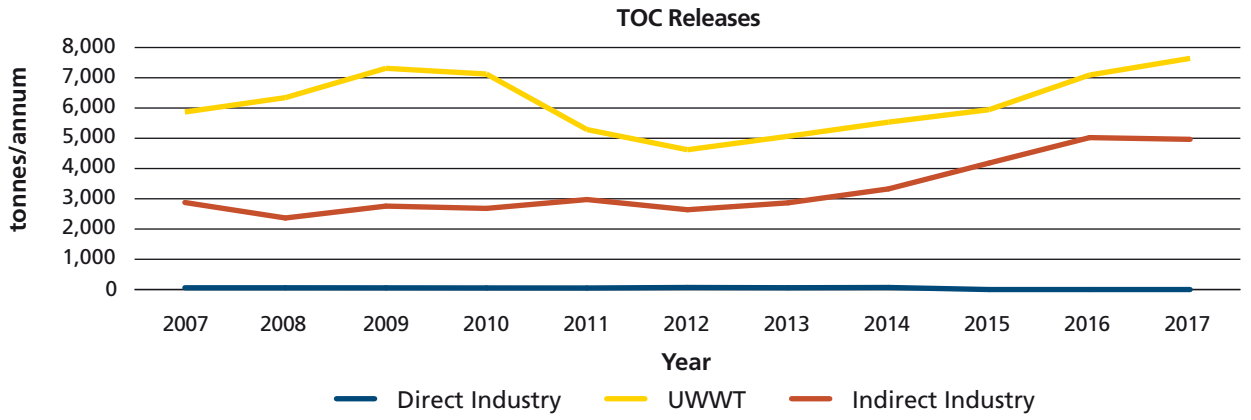


Figure 10.7 Total reported TOC releases from industry (direct/indirect) to water and urban wastewater releases to water in the period 2007-2017 (Source: EPA http://www.epa.ie/enforcement/prtr/)



Emissions to Air from Industrial Facilities

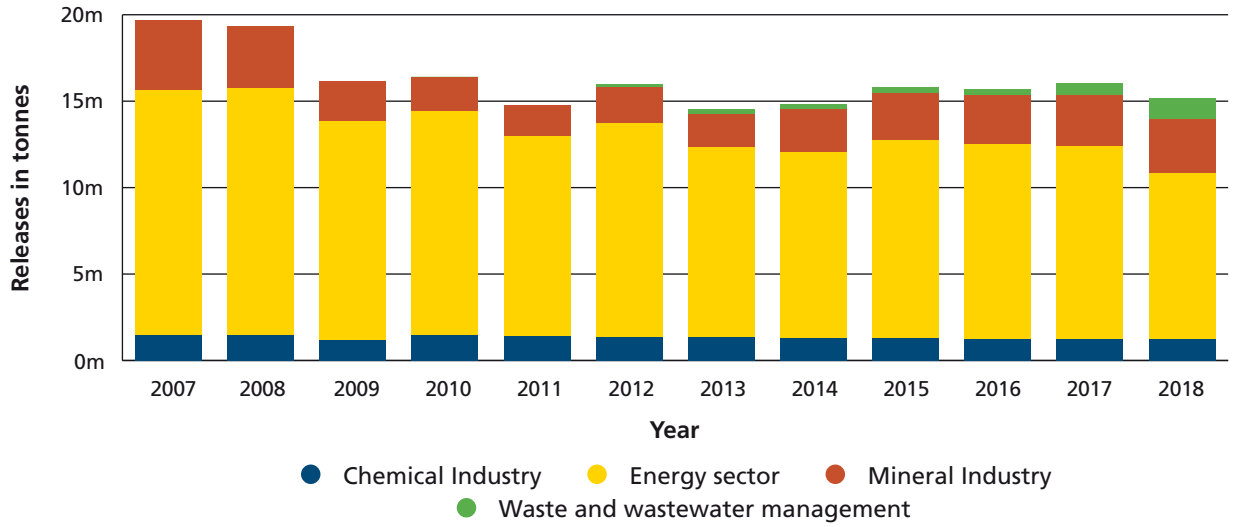
Emissions to air from licensed facilities, including power stations, represent a significant proportion of Ireland's emissions to air of greenhouse gas and other air pollutants, including sulphur dioxide, nitrogen oxides and particulate matter.

Industrial pollutant releases to air include releases of greenhouse gases such as carbon dioxide and methane, and acidifying pollutants such as sulphur oxides. Also included are pollutants that can have impacts on human and environmental health, such as nitrogen oxides, particulate matter (in this case, particulate matter of 10 microns or less in diameter, PM_{10}) and heavy metals including, in particular, cadmium, lead and mercury. Releases of these pollutants to air can affect ambient air quality. Local air quality is, however, also determined by how these pollutants disperse in the atmosphere.

Emissions to air from licensed sites come mainly from the energy and mineral sectors (cement) and represent a significant proportion of Ireland's emissions to air: 30 per cent of greenhouse gases (mainly carbon dioxide and methane), 45 per cent of sulphur dioxide, 15 per cent of nitrogen oxides and 15 per cent of $PM_{2.5}$ (EPA, 2020). The impacts of air pollutants on human health and vegetation are dealt with in Chapter 3 of this report. Greenhouse gas emissions from industry are addressed separately by the EU emissions trading system (EU ETS; Directive 2003/87/EC) (Chapter 2).

Pollutant releases to air of carbon dioxide from industrial facilities decreased by 23 per cent between 2007 and 2018 (Figure 10.8). The most recent figures, from 2018, show that 21 facilities reported carbon dioxide releases of 15,200 kilotonnes, with the energy sector responsible for 63 per cent of the total. In 2018, carbon dioxide releases comprised more than 99 per cent of the total reportable pollutant greenhouse gas release to air of 15,279 kilotonnes, as reported in the Pollutant Release and Transfer Register.

Figure 10.8 Total national carbon dioxide releases (Source: EPA http://www.epa.ie/enforcement/prtr/)



Large Combustion Plants

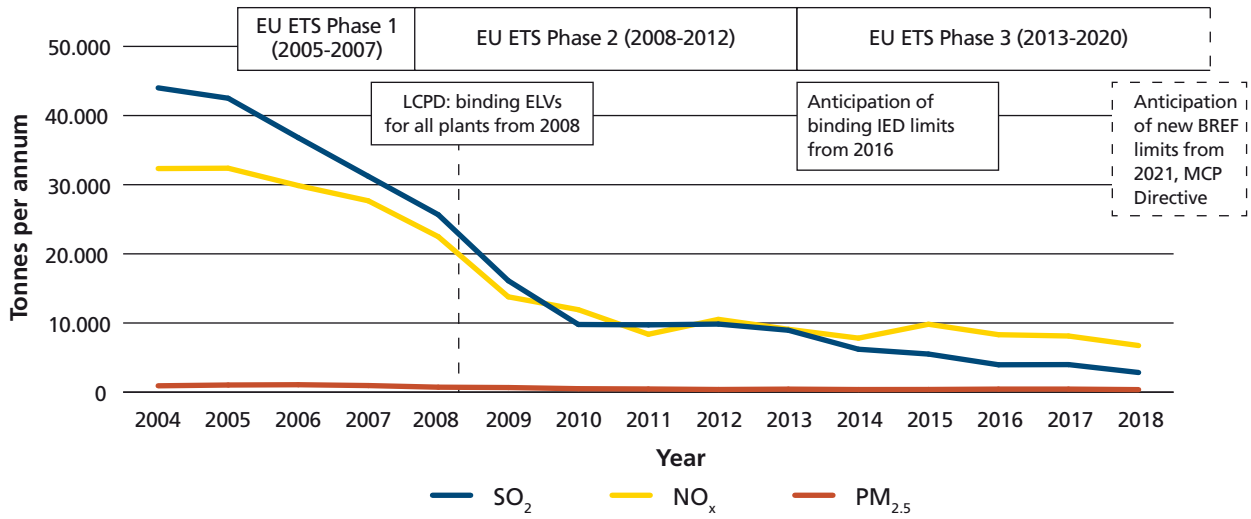
Improvements in emissions from large combustion plants, including the energy sector, in recent years can be attributed to increased regulation and tighter emission limit values.

Large combustion plants are typical backbone infrastructures producing electricity and/or heat across industrial sectors, including in electricity supply, oil refineries, food and some chemical industries. Across Europe, these facilities contribute to 47 per cent of sulphur dioxide emissions, 15 per cent of nitrogen oxide emissions and 2 per cent of dust (as total suspended particles) emissions. (EEA, 2020a). Since 2004, emissions from large combustion plants in the 28 EU Member States have decreased: by 86 per cent for sulphur dioxide, 59 per cent for nitrogen oxides and 84 per cent for dust (as total suspended particles) (EEA, 2020b).

In an Irish context, there have also been considerable improvements in emissions from the energy sector in the past few years. These improvements are mainly attributed to increased regulation under the EU Emissions Trading Scheme and the IED, with associated tighter emission limit values requiring improved abatement, changes in fuel mix and improvements in energy efficiency (Figure 10.9). In parallel, there has been a significant reduction (over 95%) in emissions of heavy metals (cadmium and nickel) to air from the sector in the past 10 years.

The new BAT conclusions on large combustion plants will become the reference for setting licence/permit conditions in Europe. As well as being more stringent, the new requirements also consider new classes of pollutants, notably mercury, hydrochloric acid, hydrogen fluoride and ammonia. The implementation of the Medium Combustion Plant (MCP) Directive, which recently came into force for plants between 1 and 50 MW, will further reduce emissions of key air pollutants such as nitrogen oxides and PM_{10}.

Figure 10.9 Emissions from the energy sector in Ireland (Source: EPA, 2020)



Ammonia Emissions from Facilities in the Intensive Agriculture (Pig and Poultry) Sector

The intensive agriculture (pig and poultry) sector accounts for approximately 10 per cent of the ammonia emissions arising in Ireland.

As outlined in Chapter 13, the agriculture sector accounts for virtually all (99%) ammonia emissions in Ireland. The EPA regulates the intensive agriculture (pig and poultry) sector, which combined accounts for approximately 10 per cent of these emissions. The BAT conclusions for this sector, which must be complied with by 2021, set, for the first time at the EU level, limits for ammonia emissions to air from animal housing and for excretions of nitrogen and phosphorus for various categories of pigs or poultry. Compliance with the ammonia limits will require an ammonia control programme incorporating measures such as nutritional management, forced ventilation, air cleaning and cooling systems and, in specific cases, abatement techniques.

3. Resource Use in Industrial Sectors

Industrial sectors account for a fifth of total energy consumption in Ireland (SEAI, 2018). Over half of this energy is consumed by three sectors in producing food, basic metals and non-metallic mineral products (e.g. cement and lime). The growth of data centres means that this sector is expected to be a large energy consumer in the future.

The EPA is required to consider energy efficiency in assessing licence applications, while for certain sectors the BAT conclusions set thermal energy consumption levels that are incorporated into EPA licences.

The data available regarding water consumption from the industrial sector in Ireland is limited, and limited data is also available from Eurostat (2017a,b). Information around water consumption is expected to improve with the new water abstraction licensing system that the EPA is now bringing into operation. Analysis of water consumed by 100 EPA-licensed facilities in 2014 (Stockil *et al.*, 2016) revealed that the largest water users or abstractors are the food sector, production of basic metals, non-metallic mineral production and mining.

Topic Box 10.3 Data Centres and Energy Usage

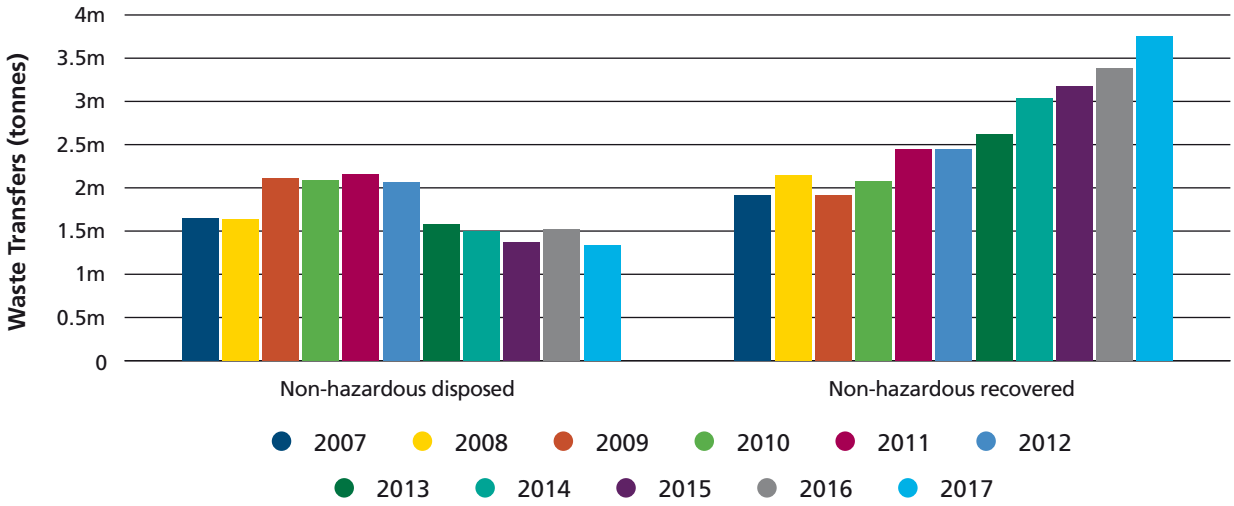
Data centres underpin our digital economy by processing, storing and transacting digital data. While they run solely on electricity, most facilities maintain standby generators to provide continuous power in the event of an emergency, such as a grid supply failure. Many sites also have dual supplies within the distribution network to minimise the risk from local supply disruption. Data centre energy demand was estimated at 10 per cent of electricity consumption in 2019 (Bitpower Energy Solutions, 2020).

By 2028, data centres could account for 29 per cent of Ireland's electricity consumption in a median demand scenario (EirGrid Group, 2019).

The Industrial Emissions Directive (IED) applies to installations with generating capacity of 50 MWth (thermal input) and above, and includes standby plants. Data centres with on-site emergency generating capacity (e.g. diesel generators) only, which do not generate primary power on site, will not generally require an IED licence though the individual generators are required to be registered in accordance with the Medium Combustion Plant (MCP) Directive. The MCP Directive applies to combustion plants with a rated thermal input capacity of between 1 and 50 MWth. The registration deadline depends on the capacity of the plant and whether it is new or existing plant Most data centres operating in Ireland fall into this category. There are currently (November 2020) 171 registered generators.[4]

4 http://www.epa.ie/mcp/#/register.

Figure 10.10 Total national non-hazardous waste transfers 2007-2017 (Source: EPA http://www.epa.ie/enforcement/prtr/)



4. Waste Generated by Industrial Sectors

Industrial sectors account for around two-thirds of the total hazardous waste generated in Ireland, with the chemical industry producing a quarter of this amount.

Hazardous waste can pose a risk to health or the environment if not managed and disposed of correctly. The IED is the primary policy initiative in relation to the regulation of waste-related aspects of industrial activities. In general, the primary focus of the IED regulatory regime is more on the management of environmental releases and there has been less emphasis on minimisation and recovery, including preparing waste for reuse, within the licensing process. This is likely to change in the future, as there could be more emphasis on the development of the circular economy for resource use and waste.

Industrial sectors accounted for just over half (56%) of the total non-hazardous waste generated in Ireland in 2016, with the food and drink sector representing a large proportion (16%). See Figure 10.10 for details. There were significant year-on-year increases in the recovery of non-hazardous waste between 2011 and 2017. These are partially attributed to waste flows going to the waste to energy (incinerator) facilities that became operational in these years.

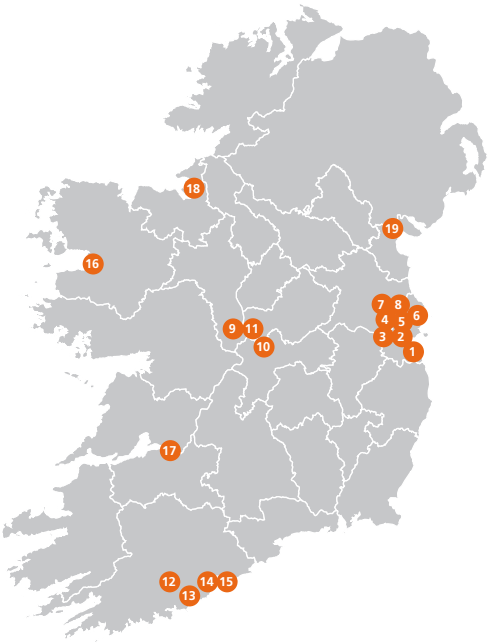
Industrial sectors also accounted for around two-thirds (67%) of total hazardous waste generated in Ireland in 2016, with the chemical industry representing the largest proportion (25%) (Eurostat, 2019). The cement and lime sector (18%) is also significant (Eurostat, 2019). In the chemical sector there has been a switch to cleaner biosynthesis production in recent years in Ireland, with less hazardous waste generated per installation as a consequence (Topic Box 10.4).

Topic Box 10.4 Transition to Cleaner and More Efficient Biologically Based Pharmaceutical Production

The chemical/pharmaceutical industry represents the largest share of total hazardous waste generated in Ireland. The industry is making significant efforts to develop cleaner and more efficient processes for manufacturing pharmaceuticals.

In recent years in Ireland there has been a transition from the manufacture of active pharmaceutical ingredients (APIs) by bulk synthesis and chemical API manufacture to biologically based production processes. Over the last 10 years, Ireland has received over €10 billion of investment in biopharmaceutical production. This investment has resulted in Ireland's biotechnology manufacturing base increasing from 3 facilities in 2004 to over 20 facilities in operation, under construction or in planning today. Six of the top 15 best-selling pharmaceuticals worldwide are produced in Ireland (Central Bank of Ireland, 2020).

Figure 10.11 Location of biologically-based pharmaceutical production installations in Ireland



1	P0019-02	Amgen Technology (Ireland)	Dun Laoghaire, Dublin
2	P0652-01	Pfizer Ireland Pharmaceuticals	Clondalkin, Dublin 22, Dublin
3	P0693-01	Takeda Ireland Limited	Nangor Road, Dublin 22, Dublin
4	P1030-01	Alexion Pharma	Blanchardstown, Dublin 15, Dublin
5	P0552-02	Swords Laboratories	Mulhuddart, Dublin 15, Dublin
6	P1106-01	MSD Ireland (Biotech Dublin)	Swords, Co. Dublin
7	P1073-01	Takeda Dunboyne Biologics Ltd.	Dunboyne, Meath
8	P1060-01	Mallinckrodt Pharmaceuticals Ireland Ltd,	Blanchardstown, Dublin 15, Dublin
9	P0110-02	Arran Chemical Company Ltd.	Athlone, Roscommon
10	P0638-01	Zoetis Belgium S.A.	Tullamore, County Offaly
11	P1094-01	Alexion Pharma	Athlone, Roscommon
12	P0005-02	MSD Ireland (Brinny)	Innishannon, Cork
13	P0009-03	Eli Lilly Kinsale Limited	Kinsale, Cork
14	P0864-01	BioMarin International Ltd.	Ringaskidddy, Cork
15	P0778-02	Janssen Sciences Ireland UC	Barnahely, Ringaskiddy, Cork.
16	P0126-03	Allergan Pharmaceuticals Ireland	Westport, Mayo
17	P0991-01	Regeneron Ireland	Raheen, Limerick
18	P1087-01	AbbVie Ireland NL B.V.	Ballytivnan, Sligo
19	P1122-01	Wuxi Biologics Ireland	Dundalk . Co Louth

Biologically based production processes represent a clean and safe option for the manufacture of human medicines by virtue of the following characteristics:

- low emergency or fire risk due to small quantities of chemicals
- low hazardous waste generation (no hazardous chemicals involved in the manufacturing process other than minor quantities for chromatography storage and cleaning purposes)
- low atmospheric emissions (little or no volatile organic compound emissions due to the small quantities of solvents or other hazardous chemicals in manufacturing process)
- inherently low environmental risk because of the water-based process.

The data are not yet available to undertake a fully robust analysis of the environmental performance of pharmaceutical production by biologically based production methods, as there are only a small number of sites currently in full production, although a number are moving into full-scale production in the coming years. (See Figure 10.11). Based on the available data to date, it is apparent that hazardous waste generation is a fraction of that from traditional chemical production. Non-hazardous waste generated and water use are of a similar order of magnitude based on the small number of actual biologically based production sites that are fully operational at present.

The EPA plans to undertake a fuller analysis of the environmental footprint of the biologically based production installations in the coming years when there is a greater number of sites in full production.

The actual number of facilities that report hazardous waste transfers (e.g. conveyance off-site for treatment elsewhere) of greater than 2 tonnes is outlined in Figure 10.12. It is noteworthy that one-quarter of the facilities reporting hazardous waste transfers are from the energy and food and drink sectors whereas, in tonnage terms, transfers from these sectors combined are less than 1 per cent of Ireland's total hazardous waste.[5]

There was an overall increase in hazardous waste transferred from EPA-licensed facilities in the period 2007-2017. There were significant increases in hazardous waste recovered in Ireland and abroad, and decreases in hazardous wastes disposed of in Ireland and abroad in this period (Figure 10.12). The figure illustrates the large quantities of hazardous waste transferred in 2008 from the remediation of contaminated soil from a closed industrial facility that had been involved in the production of glass.

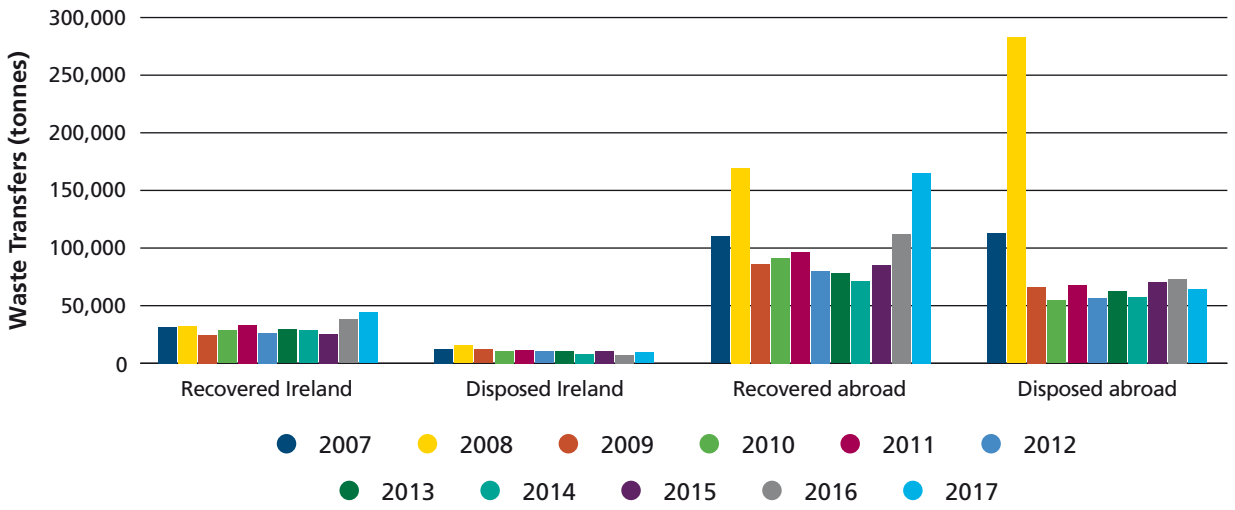
The data on hazardous waste transfers indicate that the positive trend to send hazardous waste for recovery treatment, rather than disposal, continued in 2017. However, they also highlight that Ireland has not moved significantly towards self-sufficiency. A lack of domestic infrastructure, due in part to economies of scale, and potential for public opposition, combined with the often more favourable cost option of treatment and disposal abroad, have meant that export continues to be a significant treatment route for Ireland's hazardous waste. Further details relating to industrial waste management nationally are presented in Chapter 9.

5. Circular Economy for Resource Use and Waste

Policy measures in the circular economy, waste and resource efficiency areas, including possible BAT conclusions, could help to reduce industrial waste generation and improve recovery in the coming years.

There are generally no site-specific targets set against which waste minimisation or waste recovery rates can be benchmarked. The implementation of BAT conclusions (Topic Box 10.2) is likely to have some positive influence in terms of energy efficiency, minimising resource use and waste generation, and promoting the efficient management of materials and residue recovery. BAT conclusions typically have several specific waste and resource efficiency-related conclusions, which are implemented by IED installations. However, in general these waste-related BAT conclusions tend to be qualitative rather than setting specific quantitative targets. It thus remains to be seen exactly how effective the BAT process will be in influencing waste generation and recovery levels. A recent report by Ricardo Energy & Environment and VITO (2019) highlighted greater opportunities for IED to contribute to the circular economy through the publication of the final number of sectoral BAT conclusions.

Figure 10.12 Total national industrial hazardous waste transfers in the period 2007-2017 (Source: EPA http://www.epa.ie/enforcement/prtr/)



5 http://www.epa.ie/enforcement/prtr/

Apart from the specific waste management or industry-related policies, other broader policy measures in the waste and resource efficiency area will also have a positive impact on industrial waste generation and recovery in the coming years, specifically policy measures in relation to the circular economy.

The European Commission's Circular Economy Package (EC, 2018), one of the main blocks of the European Green Deal agenda for sustainable growth, sets out a strategic framework of measures that will help stimulate Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs. As part of the Circular Economy Package, the Commission will clarify rules on by-products and end-of-waste status. This will help support the development of industrial symbiosis – a process by which the waste of one company can become resources for another company.

Industrial symbiosis is also already used extensively at site level by many production installations. For example, many use exothermal processes delivering heat to processes requiring additional energy. There are many examples of industrial symbiosis at a national level, including:

- ash from power sector used in cement industry or brick manufacture
- by-product from chemical plant used as fertiliser
- solvent recovery for use in paint manufacture
- hazardous solid waste material recovered for use as a biomass fuel.

More recently, as part of the European Commission's European Green Deal (EC, 2019) launched in December 2019, there will be a considerable step up in action on chemicals. The Green Deal is a core part of the Commission's growth strategy, and it includes ambitious measures to tackle climate and environment-related challenges, including action to advance 'Towards a zero-pollution ambition for a toxic free environment'. As part of this action to ensure a toxic-free environment and eliminate pollution, the Commission plans to present a chemicals strategy for sustainability. This strategy will aim to better protect citizens and the environment from hazardous chemicals and encourage innovation in the development of safer and more sustainable alternatives.

6. Enforcement of EPA Licences for Industrial Facilities

A range of enforcement options are open to the EPA to deal with licence breaches.

After a licence is issued by the EPA, inspectors from the EPA's Office of Environmental Enforcement are tasked with the enforcement of the licence. The IED contains mandatory requirements on environmental inspections. The EPA has robust systems in place covering environmental inspections and draws up annual inspection plans accordingly. The IED requires site visits at frequencies ranging from every year to every 3 years, depending on environmental risk-based criteria.

Where licence breaches are detected, the EPA can take a number of enforcement actions. These include recording non-compliances with licence conditions; undertaking additional site inspections, audits or emissions monitoring; opening compliance investigations; issuing statutory notices; taking prosecutions or injunctions; and ultimately suspending or revoking a licence if the environmental issue has not been satisfactorily resolved.

The EPA Compliance and Enforcement Policy[6] sets out the enforcement actions the EPA takes, having regard to five guidance principles: risk based, proportionality, consistency, transparency and the polluter-pays principle.

The EPA receives complaints from members of the public in relation to licensed facilities. Each complaint is recorded and investigated; some may require a visit to the site in question. In total 84 per cent of all complaints received from the public relate to odour (57%) and noise (27%).

One enforcement tool the EPA employs is the National Priority Sites system, which identifies and publishes the names of licensed sites that are enforcement priorities. Each licensed site receives a score based on its compliance status against four criteria: compliance investigations, complaints, incidents and non-compliances. The first National Priority Sites list was launched by the EPA in July 2017 and the list has been updated and published at the end of each quarter since then. Sites come off the list when they have made the necessary improvements in compliance. Summary information on the National Priority Sites during 2019 and 2020 is given in Figure 10.13 below.

6 http://www.epa.ie/pubs/reports/enforcement/oeeenforcementpolicy.html

Only 2 out of the 20 sites that were National Priority Sites during 2017 were on the list at the end of the fourth quarter of 2019. This demonstrates the effectiveness of the system in driving compliance and reflects significant environmental improvements in compliance at 18 sites.

Figure 10.13 National Priority Sites summary details in 2019 and 2020

National Priority Sites

12	Sites were an National Priority Site in 2020
28%	of all non-compliances recorded for all licensed sites to end of Q3 2020 were for National Priority Sites
3	Sites were National Priority Sites for the first three quarters in 2020
52%	of all complaints received in 2020 were in relation to National Priority Sites; odour and noise were the key issues for the public
11	The Food and Drink Sector (4) and the Waste Sector (3) had the most National Priority Sites during 2019

The food and drink (agri-food) sector continues to face challenges in maintaining environmental compliance as the industry adapts to increased agricultural production and intensification under the Harvest 2020 and Foodwise 2025 strategies. Although this sector again had the poorest compliance record in 2018 and 2019, it should be noted that there are many operators within this sector that operate in compliance and manage their facilities in an environmentally sound manner.

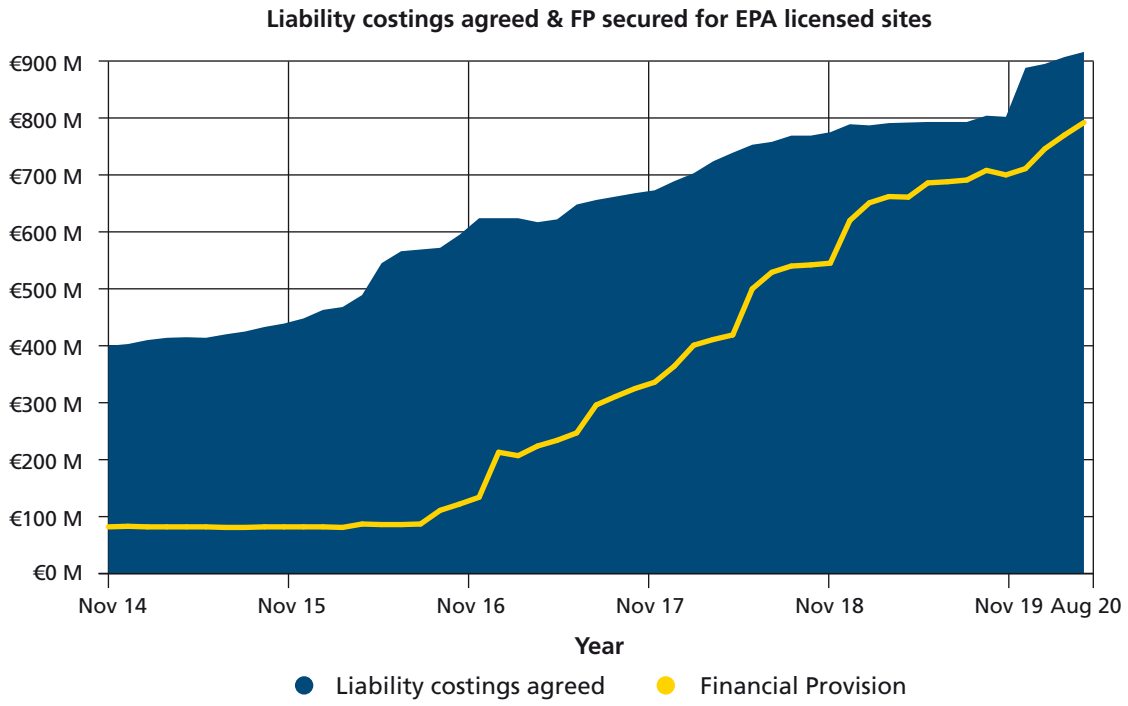
Financial Provisions for the Remediation and Proper Closure of Industrial Sites

The prevention and remediation of environmental damage from the closure of authorised activities are strategic priorities for the EPA.

In recent years, the EPA has made significant progress in ensuring licensees make financial provision to cover environmental liabilities at licensed sites. Financial provision is required to pay for site remediation, aftercare and any potential clean-up that may be required, for example following an incident. Having adequate financial provision in place is essential to manage environmental risks and to minimise the exposure of the state to the cost of remediating environmental damage if operators fail to do so.

The total costs agreed for the environmental liabilities of EPA licenced sites were €912 million by the end of August 2020 and the amount of financial provisions in place was €792 million (Figure 10.14).

Figure 10.14 Financial provision in place November 2014 to August 2020 (Source: EPA)



7. Industry and the National Transition Ambition

Demonstrating and measuring sustainability and adapting to climate change are key challenges for Irish industry.

Although significant uncertainties exist regarding the extent and impact of climate change in Ireland on industrial sectors, it is vital that industry seeks to reduce its exposure to projected changes. A recent report by the United Nations Framework Convention on Climate Change (UNFCCC) showed that a group of the world's largest companies, worth collectively nearly $17 trillion, have valued the cost of climate change risks to their businesses at almost $1 trillion. On the positive side the authors also noted potential gains from business opportunities of almost $2 trillion (CDP, 2019). Therefore, having robust plans in place to adapt to climate change is key to business success. One such approach is the adoption of ISO 14090 'Adaptation to climate change – principles, requirements and guidelines'. Achievement of this standard aims to help organisations assess climate change impacts and put plans in place for effective adaptation. Other business-led initiatives such as green accounting and green investments, carbon disclosure and corporate social responsibility (CSR) programmes, also contribute to transition imperatives. The National Plan for Corporate Social Responsibility (DJEI, 2017), promoting environmental practices that enhance a company's profile and competitiveness, remains a very relevant transition-supporting policy.

From a national perspective, the government has introduced policy measures and actions aimed at taking action on climate change. Most notably, under the Climate Action and Low Carbon Development Act 2015, there is a requirement for the government to prepare a series of national mitigation plans and national adaptation frameworks. This is covered in Chapter 2, Climate Change.

Under the National Adaptation Framework, a series of sectoral adaptation plans have recently been prepared, including a plan for the electricity and gas networks sector (DCCAE, 2019a). This plan highlights the impacts on the energy networks from observed recent weather events and incorporates a vulnerability assessment of the energy network. Gas-fired combustion turbines, for example, had available output reduced by around 8 per cent during the 2018 heat wave in Ireland. Furthermore, at least one existing plant had capacity reduced by up to 50 per cent during that heat wave because of cooling water issues (DCCAE, 2019a).

The government's Climate Action Plan, launched in 2019, sets required targets to achieve Ireland's ambition to achieve climate neutrality by 2050 (DCCAE, 2019b). Action 42, for example, requires all business representative groups, including Irish Business and Employers Confederation, Business in the Community, Irish Representative Association for Small and Medium Enterprises, Small Firms Association Chambers Ireland and others, to create partnerships of companies that sign up to a climate-neutral trajectory.

Cost-effective measures in the Climate Action Plan highlight significant opportunities and potential changes for the industrial sector, particularly in food processing and other manufacturing. In food processing, measures include phasing out the use of oil as a fuel and replacing it with biomass and electricity. In cement production, measures include the use of alternative fuels, such as solid recovered fuels and other waste streams, substituting for fossil fuels. Increasing the use of alternative fuels in the cement sector to 80 per cent by 2030 will help to offset a forecast 40 per cent increase in production over the period (DCCAE, 2019b). An immediate priority of the plan is to establish networks in key sectors, including data centres, pharmaceuticals, and food and drink, to promote industry-led sectoral plans (see Topic Box 10.3).

Breakthrough technologies such as carbon capture, utilisation and storage and hydrogen could, in theory, help heavy industries such as cement and chemicals achieve high levels of decarbonisation. Indeed, the future viability of companies in these subsectors may come to depend on the commercialisation of these technologies (CDP Europe, 2020).

8. Research on Industry and the Environment

Research programmes are vital for providing integrated solutions for many of the complex environmental challenges facing the industry sectors in Ireland.

The EPA has a statutory role in coordinating environmental research in Ireland. Since 2016, the EPA has funded up to 46 new research projects relevant to the Environment and Industry area; a commitment of €5.3 million. Funding came from the EPA Research Programme 2014-2020 and the EPA Green Enterprise Scheme.

These projects include research undertaken by teams in Queen's University Belfast and the National University of Ireland Galway that identified several phosphorus treatment and recycling technologies that could effectively compete with existing technologies and provide small- to medium-scale solutions for the agri-food sector (Macintosh *et al.*, 2019). This research project followed a related study by Ryan *et al.* (2016), which evaluated phosphorus recovery technologies in an Irish context. Further work is ongoing in University College Cork aiming to demonstrate a circular economy approach to dairy-processing wastewater through the reuse of valuable components in the effluent within the local and global economy. The Algeopolymer project, led by a team in the University of Limerick, researched the potential reuse of industrial wastes, such as bauxite and fly ash, as core ingredients in geopolymer cement (Ujaczki *et al.*, 2019).

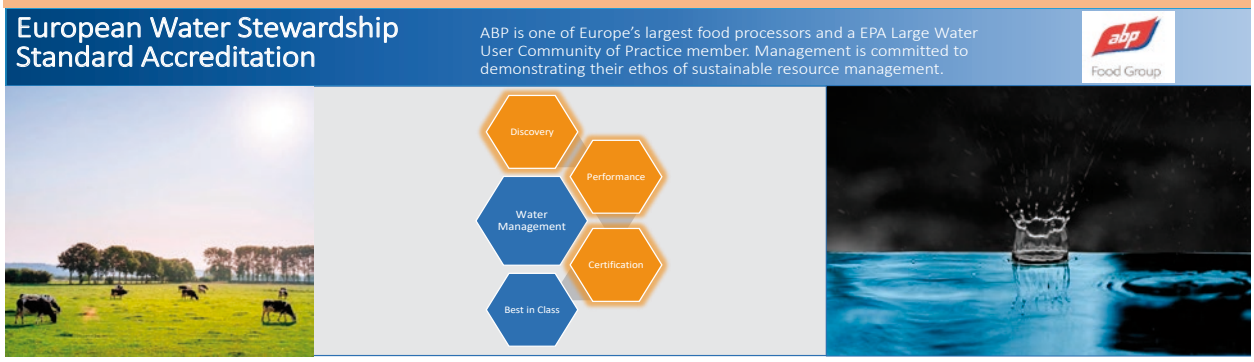
Funded research can also assist the EPA in identifying behavioural change tools to promote going beyond compliance in the regulated community (Keely *et al.*, 2020) and to assist smarter remote enforcement (Collins *et al.*, 2014; McDermott *et al.*, 2015).

Research programmes provide integrated solutions for many of the complex environmental challenges facing industry. A case in point is current research also under way at the University of Limerick with industrial partners. The team is looking at the potential of waste and the opportunity it presents to recover valuable metals from the likes of mine tailings, bauxite residue and industrial filter cakes.

The concept of water stewardship allows companies to understand their water-related risks and implement strategies that minimise them and promote the business's long-term sustainability. These risks may be physical, reputational, financial or regulatory. Following consultation with major water users in Ireland, Stockil *et al.* (2016) reported exciting opportunities to further improve Ireland's attractiveness as an investment location and as a leader in water stewardship practices on the international stage (Figure 10.15).

At a global level, the area of monitoring emissions from industry is expected to be revolutionised with the launch of a new satellite system capable of tracking air pollutants from every large power station in the world in real time. Developed by the non-profit emissions reduction software company Watt Time and supported by Google, the project will use a global network of satellites to measure carbon dioxide emissions before making the data public. Satellite technologies cannot replace all ground-based monitoring, and it remains to be seen how steady and sensitive the measurements will be, but, if successful, this approach could supplement enforcement efforts.

Figure 10.15 European Water Stewardship Standard Certification for Responsible Water Practices (Source: Central Solutions, 2017)



Lean water tools :

- Gap Analysis

'The insight provided by the analysis created a clear roadmap tailored to our firm, streamlining our certification process.'

Before:

To help reach its 2020 corporate targets in terms of reduced resource consumption ABP sought to achieve certification with the European Water Stewardship at their site in Cahir. This accreditation process involved meeting a number of criteria site-wide related to sustainable water management in terms of water quantity, quality and governance.

After:

Central-Solutions performed gap analysis at the site, which began with benchmarking the sites performance against individual criteria listed in the standard in order to highlight areas that needed further improvement. Ideas and strategies were then developed to improve on these areas so that all of the necessary criteria were met in time for certification.

Benefits:

- ABP Cahir was the first food processor in Europe to achieve Gold status of the EWS standard for responsible water practices, demonstrating their continued commitment to resource management
- The EWS standard helped direct the firm's own improvements efforts as its criteria provide clear resource reduction goals
- Pre-Screening identified where improvements were needed and ensured resources were utilised effectively in meeting criteria
- Following success at ABP Cahir, management are keen to replicate these reductions and are currently implementing similar practices at all Irish sites

9. Conclusions

Industrial Emissions

The environmental performance of Irish industry has improved in recent decades. However, industry still generates a significant amount of hazardous waste and emissions discharged to the environment, especially air emissions.

There have been significant and sustained decreases in releases of certain air pollutants from a range of industries in the period 2007-2017. Releases of sulphur oxides, nitrogen dioxide, nitrogen oxides and PM_{10} particulate matter have significantly decreased. These decreases are due to changes in the fuel type used at combustion plants and improvements in abatement technology at these and a range of other facilities, including the cement, food and drink, and chemical sectors. Decarbonisation of industry, stimulated by climate change mitigation policies, is expected to be the main driver of further reductions in industrial air pollutant and greenhouse gas emissions in the medium and long terms.

Greening Industry

While the Industrial Emissions Directive and earlier legislation have delivered concrete achievements in reducing pollution, a transition to a greener industrial sector will require integrated approaches, with stronger control of pollution at source and the use of innovative technologies. These policy-driven reductions are a clear success story to build upon. Challenges, however, remain for the energy sector in terms of transforming it to meet the environmental and decarbonisation targets now required.

Food, Drink and Intensive Agriculture Sectors

The food and drink (agri-food) sector continues to face challenges in maintaining environmental compliance as the industry adapts to increased agricultural production and intensification under the Harvest 2020 and Foodwise 2025 strategies.

The trend of increased releases in ammonia and methane to air from the intensive agriculture sector is due to an increase in the number of these facilities and in expansions at existing installations, driven in part by the growth of agricultural export activity.

Waste

Positive trends include recent increases in industrial waste transfers undergoing recovery and reductions in waste undergoing disposal. The change can be viewed as movement towards the implementation of EU waste policies where increasing emphasis is placed on the higher tiers of the waste hierarchy of prevention and minimisation, reuse, recycling, recovery and disposal. However, the overall increase in quantities of hazardous and non-hazardous waste transfers suggests that there is scope for improvement in resource use and consumption in industrial facilities.

Hazardous Waste

The data on hazardous waste transfers indicate that the positive trend of increasingly sending hazardous waste for recovery treatment, rather than disposal, continued in 2017. However, they also highlight that Ireland has not moved significantly towards self-sufficiency. A lack of domestic infrastructure, in part due to a lack of economies of scale and the often more favourable cost option of treatment and disposal abroad, has meant that export continues to be a significant treatment route for Ireland's hazardous waste.

Best Available Techniques (BAT)

Several of the sectoral BAT conclusions produced in the past few years will require a technical assessment of almost half the existing EPA licences from the intensive agriculture, chemical, energy, food and drink, and waste treatment sectors in the coming years. This process represents an opportunity to modernise installations and keep environmental protection in Ireland in line with developing technologies and standards.

The impacts and costs of pollution from industry to the environment and human health remain high. Industry will need continued improvements in emission reductions and abatement technologies. Existing policy instruments are expected to lead to further reductions in industrial emissions but current policies do not address the full scope of the industrial pollution load to the environment.

Future Regulation and Integration

A review of the implementation of the Industrial Emissions Directive across Europe is under way at present. As part of this exercise, the European Commission is looking at the case for the regulation of additional activities (e.g. aquaculture) and at greater regulatory coherence across European legislation including the Water Framework Directive, the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation, the IED, and so forth. These changes will ensure a consistent approach across EU Member States in preventing, reducing and eliminating, as far as possible, emissions arising from industrial activities into air and water and onto land.

Chapter Highlights for Environment and Industry

Pollutant emissions to air from industry represent a significant proportion of Ireland's total air emissions. However, releases of air pollutants by industry have significantly decreased (by over 70%) during the past decade. Overall, environmental regulation and improved pollutant abatement technology, among other factors, have delivered significant reductions in pollution and will continue to do so under new tighter standards up to 2030.

The food and drink sector continues to face many challenges in maintaining environmental compliance as the industry adapts to increased agricultural production and intensification. This sector has featured strongly on the EPA priority sites list. Investment is needed to ensure that facilities in the food and drink sector meet their environmental obligations set out in EPA licences covering areas such as odour controls, noise limits and the operation of wastewater treatment systems.

Environmental regulation provides a requirement that industry modernises and meets best practice in relation to controls on waste and emissions, as these actions taken to reduce emissions contributes a large dividend in terms of environmental and human health improvements. Industry can gain competitive advantages and more local support from being sustainable and having a good environmental compliance history.

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