1. Introduction to the OECD Environment, Health and Safety Programme

This chapter explores the economic and environmental aspects associated with the chemical industry. It then discusses how the OECD Environment, Health and Safety (EHS) Programme helps OECD governments reduce barriers to trade, optimise the use of their resources, and save industry time and money by co-operating to test and evaluate the safety of biocides, industrial chemicals, pesticides and nanotechnology products. The chapter describes how the EHS Programme helps to achieve these goals through harmonisation, burden sharing, exchanging technical and policy information, international co-operation, ensuring green growth, and contributing to sustainable development.

1.1. Background

Governments today are striving to design and implement cost-effective policies for "greener" and more innovative sources of growth and more sustainable consumption. How such policies are implemented in the chemical industry will be critical to achieving sustained success. The chemical industry is one of the largest economic sectors in the world and contributes significantly to the living standards and health of people, but it also potentially has a negative impact on human health and the environment.

Given the potential environmental and health risks associated with the production, transport, use and disposal of chemicals, the sector is highly regulated. Regulations cost money – to both industry and governments. The fact that each OECD country has its own regulatory processes and requirements, with many of the same chemicals being involved and traded amongst them, means that much effort is potentially duplicated and time and money wasted.

It is for these reasons that the OECD's Environment, Health and Safety (EHS) Programme has been working for more than 40 years to harmonise chemical safety tools and policies. In addition to dealing with the safe use of industrial chemicals, manufactured nanomaterials, pesticides, biocides and products of modern biotechnology, the programme addresses related areas of concern and interest, such as chemical accidents and releases of hazardous chemicals and pollutants to the environment (e.g. by assisting countries to set up Pollutant Release and Transfer Registers). Its aim is to allow governments and industry to develop the most cost-effective approaches for protecting human health and the environment from the risks posed by chemicals, avoiding duplication of effort, and ensuring barriers to trade avoided.

Much of the EHS Programme's work is in line with the policy recommendations in the *OECD Environmental Outlook for 2050* (OECD, 2012a), which stress the need to intensify international co-operation in the management of chemicals, including by:

- sharing work on the assessment of chemicals and development of methodologies for assessing existing, emerging or poorly understood issues (e.g. endocrine disrupters, nanomaterials, per- and polyfluoroalkyl substances, and chemical mixtures)
- increasing the sustainable use of chemicals and green chemistry
- implementing policies to protect the most vulnerable human life stages (i.e. early life).

This chapter explores the economic and environmental aspects associated with the chemical industry. It then discusses how the OECD's EHS Programme helps OECD governments reduce barriers to trade, optimise the use of their resources, and save industry time and money – more than EUR 309 million[1] – by co-operating to test and evaluate the safety of biocides, industrial chemicals, pesticides, biotechnology and nanotechnology products. The chapter describes how the EHS Programme helps to achieve these goals through harmonisation, burden sharing, exchanging technical and policy information, international co-operation, ensuring green growth, and contributing to sustainable development.

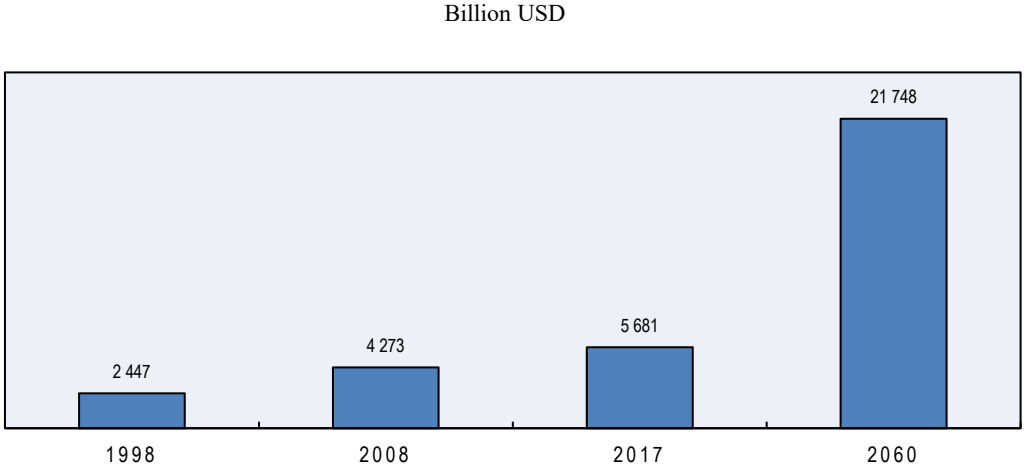
1.2. The chemical industry

The chemical industry – which includes producers of industrial chemicals, polymers, pharmaceuticals, pesticides, biocides, food and feed additives, and cosmetics – is one of the world's largest industrial sectors. Every manmade material is made of, or contains, one or more of the thousands of chemicals produced by the industry each year, from paints and insect spray to computers, kitchen appliances, medicines or sun cream. The industry is a major employer, with 3.3 million jobs in the EU chemical industry (including pharmaceuticals, rubber and plastic) and up to three times as many indirect jobs generated by this sector (Cefic, 2018). The US chemical industry (excluding pharmaceuticals) employs 529 000 people, with each job generating an additional 7.1 jobs in other sectors of the economy, such as retail trade and health care (ACC, 2018).

The chemical industry is very diverse, comprising basic or commodity chemicals (e.g. inorganic chemicals, petrochemicals, petrochemical derivatives); speciality chemicals derived from basic chemicals (e.g. adhesives and sealants, catalysts, coatings, plastic additives); products derived from life sciences (e.g. pharmaceuticals and pesticides); and consumer care products (e.g. soap, detergents, bleaches, hair and skin care products, and fragrances).

Starting from the early days of the EHS Programme, the world's chemical industry has grown in value more than ten-fold, from approximately USD 520 billion in 1978 to USD 5 681 billion in 2017 (including pharmaceuticals) (ACC, 2018). OECD countries accounted for an estimated 42% of global chemical production in 2017.[2] The value of the chemical industry has increased by 33% since the last time the OECD took stock of the costs and savings of the EHS Programme in 2010, and by a total of 132% since the first time the Organisation carried out a similar exercise, which was in 1998 (Figure 1.1). Over the period 2020-60, the OECD estimates that total world production of chemicals will increase to USD 21 748 billion (OECD, 2019).

Figure 1.1. **Annual global sales of the chemical industry**



Sources: ACC (2018), *2017 Guide to the Business of Chemistry*; OECD (2019), *Global Materials Resources Outlook to 2060: Economic Drivers and Environmental Consequences*, www.oecd.org/publications/global-material-resources-outlook-to-2060-9789264307452-en.htm

The chemical industry is a major component of world trade, with global chemical exports in 2017 (excluding pharmaceuticals) accounting for USD 1 415.6 billion (ACC, 2018). The chemical industry also constitutes a significant part of GDP in many countries. In 2016, 25% of US GDP was supported by the chemical industry (ACC, 2017).

1.3. Use of chemicals: Benefits to society but also potential risks to human health and the environment

Chemicals have a wide variety of applications and can improve people's health and well-being. For instance, pharmaceuticals have played a major role in increasing life expectancy, and agrochemicals can improve crop yields. Further, research in "sustainable chemistry"[3] has allowed safer and less hazardous substances to be developed for a number of uses. For example, the development of polymeric flame retardants has allowed for less hazardous and still efficient firefighting foam. Further, products such as insulation material and low temperature detergents can improve energy efficiency to help combat climate change, while nanocomposites can remove metals from smokestack emissions. Still other products, such as those that prevent and cure disease or improve crop yields, can improve people's lives, and manufactured nanomaterials are already revolutionising the way we produce certain types of goods such as electronic equipment, tyres, clothes and medicines. In addition, new business models such as service-oriented chemical leasing aim to reduce consumption of chemicals.

However, the production and use of chemicals can also have a negative impact on human health and the environment. Although the impacts are complex and sometimes open to scientific debate, some deleterious effects are well documented, such as those toxic chemicals that persist in the environment and that are bioaccumulative[4] (e.g. dichlorodiphenyltrichloroethane [DDT], dioxins, and polychlorinated biphenyls [PCBs])[5]. The use of nanomaterials also poses new challenges with identifying potential unintended risks to humans and the environment. Furthermore, concern has been raised about the impact of endocrine-disrupting substances on human reproduction and development (OECD, 2018a). Per- and polyfluoroalkyl substances (PFASs) form another group of contaminants of global concern, due to the demonstrated behaviour, persistency and toxicological profile of certain PFASs, as well as their potential to accumulate in the body and in food chains.[6]

Another area of recent focus is plastics. While plastics are a necessity to a modern lifestyle, there are opportunities to make plastics more sustainable and contribute to a circular economy by focusing on chemical selection at the design stage to improve a number of lifecycle impacts, ranging from feedstock to risks during use, and the ability to recycle or reuse.

While many risks have been reduced over the years, and knowledge about the risks posed by chemicals has significantly increased, more needs to be done. In 2001, OECD Environment Ministers called on the OECD to further "… develop policies and instruments to identify, prevent and manage risks to human health and the environment posed by chemicals …" and "… harmonise the risk assessment of chemicals, for example, by developing criteria for identifying inherently unsafe chemicals (e.g. for persistence, bioaccumulation, toxicity), developing new testing and assessment methods, in particular for endocrine disrupters, and expanding the Mutual Acceptance of Data" (OECD, 2001). More recently, one of the key conclusions of the *OECD Environmental Outlook to 2050*, endorsed by OECD Environment Ministers in 2012, was that:

> *... while OECD governments continue to make good progress collecting and assessing information on human exposure to individual chemicals throughout their lifecycle, knowledge gaps still exist concerning the health effects from thousands of chemicals present in the environment. More information on potential exposures to chemicals in products and in the environment, as well as the adverse effects of combined human exposure to multiple chemicals is needed.* (OECD, 2012).

1.4. Why governments work together to tackle the risks posed by chemicals

1.4.1. Impacts of a non-harmonised approach to chemical regulation and testing

Today, OECD governments have comprehensive regulatory frameworks for preventing and/or minimising the health and environmental risks posed by chemicals. Indeed, the chemical industry is one of the most regulated of all industries. The objective of regulatory frameworks is to ensure that chemical products already on the market are safe or managed in a safe way, and that new ones are properly assessed before being placed on the market. This is done by either testing specific chemicals to determine their behaviour in the environment and their toxicity in mammals and other organisms or by using predictive models, such as read-across or (Quantitative) Structure-Activity Relationships ([Q]SARs) (see Box 2.2), analysing the results, and taking appropriate action.

Such a framework, while rigorous and comprehensive, is very resource-intensive and time-consuming for both governments and industry. For instance, the cost for a pesticide company to test one new active ingredient for health and environmental effects is, on average, EUR 21.5 million,[7] and the time needed for a government to review and assess the data is around 1.95 person-years.[8] For emerging technologies, such as biotechnology and manufactured nanomaterials, the development of new test methods and regulatory approaches for safety assessment can be particularly burdensome and costly.

As many of the same chemicals are produced in more than one OECD country (or are traded across countries), different national chemical control policies can lead to duplication in testing and government assessment, thereby wasting the resources of industry and government alike. Different national policies also create non-tariff or technical barriers to trade (TBT) in chemicals. In 2018, the OECD's Trade and Agriculture Directorate issued a working paper demonstrating that, on average, the cost (*ad valorem* equivalent) of technical barriers in chemicals was 9.3% of the unit value (OECD, 2018b). Further, preliminary evidence from OECD research indicates that trade agreements that include mutual recognition and harmonisation of TBT measures, including mutual recognition of TBT conformity assessment procedures, have a positive influence on chemical trade flows, presumably by reducing trade costs associated with these non-tariff measures. Over the period 2015-17, as much as 26% of specific trade concerns raised in the World Trade Organization's (WTO) Technical Barriers to Trade Committee referred to measures citing environmental protection among their objectives.[9] Of all the environment-related measures identified in notifications to the WTO between 2009 and 2016, 18% had to do with either "chemical, toxic and hazardous substances management" or "ozone layer protection". Half of these were TBT measures.[10]

Furthermore, differences in regulations and test standards discourage research, innovation and growth, and increase the time it takes to introduce a new (and potentially safer) product onto the market. They also lead to inefficiencies for governments, because authorities

cannot take full advantage of the work done by others which would help reduce the resources needed for chemicals control.

1.4.2. Benefits of the OECD Environment, Health and Safety Programme

In order to make the process of testing and evaluation of chemicals as efficient and cost effective as possible for governments and industry while maintaining a high level of health and environmental protection, OECD countries agree on overall policies; develop harmonised instruments for their implementation; and set frameworks for, and participate in, work-sharing at the OECD.

The OECD is particularly well-suited to developing common tools and policies for chemicals for several reasons:

- OECD countries account for close to half of the world's production of chemicals (approximately 42%)[11], giving them an important global responsibility for the sound management of an industry that includes many large multinational companies.
- OECD countries have similar markets, populations, per capita gross domestic product (GDP) and levels of environmental protection, greatly facilitating the development and use of common approaches.
- All OECD countries are seeking ways to reduce government spending without compromising economic development, trade, or human health and environmental safety. By working together through the OECD, governments can ensure that sound management of chemical products is implemented in a way that is most efficient for them and for industry.

The EHS Programme was set up to help OECD governments reduce barriers to trade, optimise the use of their resources, and save industry time and money by co-operating to test and evaluate the safety of biocides, industrial chemicals, pesticides, biotechnology and nanotechnology products. The programme achieves these goals through harmonisation, burden sharing, exchanging technical and policy information, international co-operation, ensuring green growth, and contributing to sustainable development. Each of these are described in turn below.

1.4.3. Harmonisation

If national approaches to chemical regulation are harmonised, industry is not faced with a plethora of conflicting or duplicative requirements, making it easier for companies to place a product on the market and thus stimulating competition. Further, governments are provided with a common basis for working with each other, and non-tariff barriers to trade are reduced. The principal tools for harmonisation are a set of OECD Council Decisions that make up the OECD Mutual Acceptance of Data (MAD) system,[12] including the *OECD Guidelines for the Testing of Chemicals* and the *OECD Principles of Good Laboratory Practice* (GLP) (OECD, 1998). The MAD system helps to avoid conflicting or duplicative national requirements, provides a common basis for co-operation among national authorities, and avoids creating non-tariff barriers to trade. In endorsing these Decisions, OECD countries have agreed that a safety test carried out in accordance with the *OECD Test Guidelines* and *OECD Principles of Good Laboratory Practice* in one OECD country must be accepted by other OECD countries for assessment purposes. This saves the chemical industry the expense of duplicate testing for products that are marketed in more than one country. In addition, the MAD system significantly reduces the number of animals

needed for testing. The Test Guidelines and GLP Principles are continuously expanded and updated to ensure they are state-of-the-art.

A 1997 Council Decision also sets out a procedure for non-OECD economies to adhere to this system and to participate in the development of Test Guidelines and Principles of GLP, which have long formed the basis of national technical regulations related to non-clinical health and environmental safety data acceptance in OECD countries. This fulfils the major World Trade Organization (WTO) requirements for "international standards" of transparency, avoidance of trade barriers and openness of participation by all WTO members.

Box 1.1. **Benefits of Mutual Acceptance of Data for industry**

Because of MAD, sponsors don't have to assume an excess uncertainty factor in planning future resources.

– Japan Pharmaceutical Manufacturers Association

Given the expansion of testing that is required in the ecological/non-target organism area of the data requirements for pesticides, the impact of OECD Test Guidelines is significant. Our view is that acceptance of the OECD GLP-generated data is a key consideration in determining in which countries registration will be sought, therefore having a significant impact on the crop protection tools that are available in direct relationship with the Mutual Acceptance of Data principles and the acceptance of OECD GLP data. Because of this direct relationship, increasing the number of countries that are members of the OECD, or have agreements that enable the recognition and acceptance of OECD GLP data, is critically important to industry, agriculture and consumers.

– A pesticides company based in an OECD country

The cost savings from the MAD system and the continuous development of new and updated Test Guidelines and additional guidance on GLP and compliance monitoring are major benefits of the EHS Programme. Every year, many companies submit notifications or registration applications for hundreds of new industrial chemicals, biocides and pesticides. As described below, the savings to the pesticides, biocides and industrial chemicals sectors for testing new substances are more than EUR 317 million each year, if the cost of participation in the EHS Programme is excluded. This does not include the savings for testing of existing chemicals as well as other types of chemicals (e.g. pharmaceuticals, many of which are subject to non-clinical health and safety testing using OECD Test Guidelines and GLP Principles). Furthermore, animal suffering is significantly reduced as a test only needs to be conducted once. Over the last few years, the number of OECD member countries and non-member MAD adherents has increased, thereby facilitating greater harmonisation and reducing the number of potentially different new national standards for safety assessments and further increasing the savings.[13]

1.4.4. Sharing the burden

By working together to tackle chemical management issues, countries can share the workload. This saves valuable government and industry resources and allows more to be achieved more quickly. For example, through the OECD's Programme on High Production Volume (HPV) chemicals, which was concluded in 2014, the burden of testing and

evaluating the safety of these substances was shared among countries according to the number of HPV chemicals produced and imported by each country (OECD, 2013). This programme lead to the generation of hazard assessments agreed by all member countries for 1 343 chemicals. This collaborative approach saved considerable resources for governments, experts and industry (OECD, 2010).

Box 1.2. **Benefits of harmonised test methods for industry**

Data following OECD Test Guidelines are more readily accepted, timely and relevant – the input of the national experts from member countries is highly regarded and widely recognised in helping eliminate what otherwise would be several rounds of submission and comments following protocol development. With the expert input in the test method design (application of OECD Guidance Documents 1 and 34, e.g. the Solna Principles), there is more confidence in the outcome of OECD studies. Similarly, the GLP programme provides confidence in the repeatability of studies.

Further, harmonised test methods allow for proposals like Review Sharing of Acute Studies[1] (vs. work sharing) to be put forward. Review sharing, even with some fixed level of auditing, would free up significant resources for government agencies permitting limited specialist resources to work on higher value added activities such as risk assessment. If an Acute Toxicology 6 Pack[2] is sent to 30 OECD member countries, the result would be 180 reviews, 174 of which are redundant and add no value to the consumer we are all trying to protect. This level of calibration is only possible with the use of OECD Test Guidelines.

Lastly, harmonised test methods facilitate the comparison of different formulations against the same standard test, which is helpful for decision making.

– Representative of a biocide company based in an OECD country

Several years ago one country proposed to develop its own pesticide toxicology test guidelines, until it realised it had to use OECD test guidelines. If it had developed its own unique guidelines, our members may have had to conduct additional tests which could have required unnecessary animal testing, increased costs both to the regulator and to our members, and additional, needless bureaucracy.

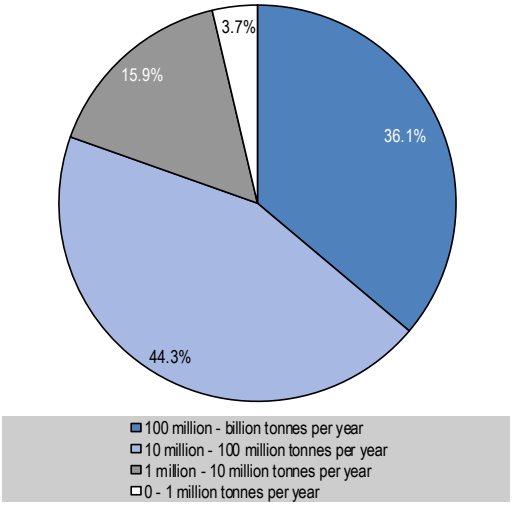
– CropLife International

Notes: 1. Review Sharing of Acute Studies is organised by the OECD Biocides Programme (see Chapter 3).
2. Acute Toxicology 6 Pack is a US standard requirement for pesticides and biocides.

While there are thousands of chemicals on the market today, only a relatively small number are produced in large volumes. In the European Union, for example, four substances account for 36.1% of the total volume of chemicals produced or imported. Substances manufactured and imported in quantities over 1 million tonnes per year (i.e. 229 substances) account for over 96% of the total volume (see the three largest categories in Figure 1.2. Under the HPV Chemicals Programme, the OECD published a list of chemicals that were produced or imported at levels greater than 1 000 tonnes per year in at least one member country/region (OECD, 2007). As, in general, the higher the volume, the greater the potential exposure to humans and releases to the environment, such large volume chemicals are likely to be prioritised by countries for assessments. As these large commodity chemicals are produced in multiple countries, there are great opportunities for OECD countries to work together on such assessments. Similarly, by sharing approaches for these chemicals using common risk assessment methodologies, companies that produce and market these chemicals in multiple countries can reduce their costs when they are assessed

by multiple countries. Costs are further reduced by allowing predictive models to be used for groups of similar chemicals so that each chemical does not have to be individually tested.

Figure 1.2. **Proportion of total EU chemical production by tonnage band**



Source: Based on data published by the European Chemicals Agency (n.d.), "REACH registration results", https://echa.europa.eu/reach-registrations-since-2008 (accessed 31 August 2018).

1.4.5. Exchange of technical and policy information

The EHS Programme provides a forum for countries to exchange technical and policy information. This creates greater confidence in, and acceptance of, each other's approaches, and ultimately fosters more efficient, effective and more closely harmonised national chemicals management programmes. For example, it is estimated that reviewing a full industry dossier on a new pesticide and writing a comprehensive report (monograph) takes a government 1.95 person-years. However, by using another country's monograph for the same pesticide – based on the OECD monograph format – government experts estimate that 1.02 full person-years of time would be saved (i.e. 52%)[14], thus generating significant savings. By discussing their chemical control policies together and seeking ways to harmonise instruments and methods, countries tend to develop similar policies and regulations. This, in turn, means that government regulators who exchange assessments can significantly reduce the time and effort needed to approve a new product or (re-)register an existing one. In this way, not only do governments save resources, products can also be brought to the market faster. Finally, governments have access to the experience of the many scientific and policy experts from other governments, industry, and academia who participate in the work of the EHS Programme.

1.4.6. International co-operation

OECD countries currently account for most of the world's production of chemicals; however, their share of the global market dropped from close to 75% in 2008 (OECD, 2008b) to 42% in 2017[15], and is expected to decrease further by 2060 as production in non-OECD economies – particularly Brazil, the Russian Federation, India, Indonesia, People's Republic of China (hereafter: China) and South Africa (BRIICS) – increases rapidly (OECD, 2019). The BRIICS countries' share in global chemical markets was 13%

in 2000 (OECD, 2012) and is expected to grow to 38% in 2020 (OECD, 2019). Some of this increase has been due to the lower costs associated with production in the BRIICS, but also with the need for facilities to be closer to final markets and feedstock sources (OECD, 2012; UNEP, 2013). In addition, technology transfer from companies in developed countries to emerging economies – due to, among other things, joint ventures and mergers and acquisitions – has helped emerging economies innovate and play a larger role in the global market (Kiriyama, 2010).

Chinese companies in particular are active in gaining access to advanced technologies in partnership with multinationals, alongside in-house research and development (Kiriyama, 2010). According to OECD estimates, China's share in global chemical production was 22% in 2011 and 26% – with a total value of USD 2 188 billion – in 2018 (OECD, 2019). The share of other Asian countries and of Latin America also increased. Africa's contribution to global chemical production remains small, but the chemicals sector is expected to play an increasingly important role in the economies of specific African countries, notably South Africa – a full adherent to MAD – which has the continent's largest chemical industry, accounting for about 5% of GDP (UNEP, 2013).

With the rapid expansion of the chemical industry in non-member economies, which could increase the potential for risks to human health and the environment, greater international co-operation with these economies will be needed to build capacity, share information and promote effective chemical management globally. Co-operation will also be necessary to ensure that new national chemical management systems do not lead to duplicative testing and assessments or to new trade barriers.

The EHS Programme has a proactive outreach strategy to encourage the participation of non-member countries in the work of the programme. This allows non-members to profit from access to technical and policy discussions and documentation, while member countries and industry profit from greater convergence of environment, health and safety programmes around the world. As a result of the EHS Programme's outreach strategy, the following non-member countries are full adherents to MAD and have the same opportunity to benefit from this system as OECD countries: Argentina, Brazil, India, Malaysia, Singapore and South Africa.

Further, the OECD has played a key role in implementing Chapter 19 of Agenda 21[16] on the sound management of toxic chemicals. Its EHS Programme is one of the leading international programmes in the field and its products are used widely by non-member countries. The Programme is increasingly involved with non-member countries and with other Participating Organisations of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC), to promote the global harmonisation of methods and approaches assisting countries in the development and implementation of their national industrial chemicals management systems (SAICM, 2018). These efforts can ensure increased savings from the EHS Programme to governments and industry.

In 2008, the OECD Council adopted a Resolution on the Implementation of the UN Strategic Approach to International Chemicals Management (SAICM) (OECD, 2008a). This Resolution calls for countries to work together through the OECD to ensure that as chemicals management programmes are established or upgraded, OECD products will be accessible, relevant and useful to non-members to help them develop their capacities for managing chemicals. The OECD is working on over 40% of the 273 activities listed in the SAICM Global Plan of Action, and contributes to the implementation of multiple work plans on emerging policy issues and other issues of concern that have been adopted by the International Conference on Chemicals Management (ICCM).

1.4.7. Ensuring green growth

The chemical industry and green innovation mutually benefit each other, as: the chemical industry and chemicals management represent scientific disciplines that influence innovation in green technologies; and green innovation plays a crucial role for the future of the chemical industry. The EHS Programme can help "green" the approaches governments take to economic growth by reducing the overall costs associated with the protection of health and the environment. Notably, the EHS Programme reduces the costs of notification of new chemicals, thereby reducing the barriers to innovation. Further, the programme allows for more existing chemicals to be assessed, potentially leading to more substitutions.

The EHS Programme contributes to the implementation of the OECD's Green Growth Strategy, *Towards Green Growth* (OECD, 2011a), through, among other things, its work on integrated pest management, the sustainable use of manufactured nanomaterials, substitution of hazardous substances and predicting the properties of chemicals without animal testing. Some of the programme's contributions to green growth are demonstrated in *Fostering Innovation for Green Growth* (OECD, 2011b), which addresses innovation as an important driver of the transition towards green growth, and *Sustainable Chemistry: Evidence on Innovation from Patent Data* (OECD, 2011c), which uses patent data to investigate green chemistry innovation trends.

1.4.8. Contributing to sustainable development

The EHS Programme helps achieve progress towards many of the UN Sustainable Development Goals (SDGs).[17] Its work on risk assessment and risk management methodologies is applicable to any type of chemical and any stage in its lifecycle, independent of their use, and addresses environmental protection for all media as well as worker and consumer safety, including the safety of children. This work therefore not only contributes to meeting SDG 12 on responsible consumption and production, and specifically Target 12.4 on the sound management of chemicals and waste, but also to Target 3.9 on reducing deaths from pollution, Target 6.3 on water quality and Target 9.4 on sustainable industries.

In addition, a number of specific programmes contribute to other SDG targets:

- The programme on pesticides and sustainable pest control contributes to Target 2.4 on sustainable food production systems and resilient agricultural practices.
- The programme on chemical accident prevention, preparedness and response contributes to Target 11.5 on reducing the number of deaths, the number of people affected and the direct economic losses relative to global GDP caused by disasters.
- The programme on Pollutant, Release and Transfer Registers (PRTRs), in addition to contributing to pollution reduction, facilitates the tracking of progress towards Target 12.5, which sets out to "substantially reduce waste generation through prevention, reduction, recycling and reuse".

Notes

1 See Chapter 2.

2. Figure provided by the ACC.

3. Sustainable chemistry is a scientific concept that seeks to improve the efficiency with which natural resources are used to meet human needs for chemical products and services.

4. Bioaccumulation refers to the gradual accumulation of substances, such as pesticides or other organic chemicals, in an organism and in the food chain.

5. See the Stockholm Convention website at: http://chm.pops.int/TheConvention/ThePOPs/The12InitialPOPs/tabid/296/Default.aspx.

6. See the OECD Portal on Per and Poly Fluorinated Chemicals at: www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals.

7. Based on the EHS survey of industry (2018). See Annex A for details.

8. Based on the EHS survey of governments (2018). See Annex A for details.

9. See the World Trade Organization's Technical Barriers to Trade Information Management System, available at: http://tbtims.wto.org/en/SpecificTradeConcerns/Search.

10. See the World Trade Organization's *Environmental Database*, available at: www.wto.org/english/tratop_e/envir_e/envdb_e.htm.

11. Figure provided by the ACC.

12. The OECD Instruments for Ensuring Mutual Acceptance of Data are available at: www.oecd.org/chemicalsafety/testing/council-acts-on-mutual-acceptance-of-data.htm.

13. Non member MAD adherents include Argentina, Brazil, India, Malaysia, Singapore, and South Africa.

14. Based on the EHS survey of governments (2018). See Annex A for details.

15. Figure provided by the ACC.

16. Agenda 21, adopted by more than 178 governments at the United Nations Conference on Environment and Development held in Rio de Janerio (Brazil) in 1992, is a comprehensive plan of action to address human impacts on the environment.

17. The 17 SDGs were adopted by the 193 countries of the United Nation's General Assembly in September 2015. Each of these goals has specific targets to be achieved by 2030.

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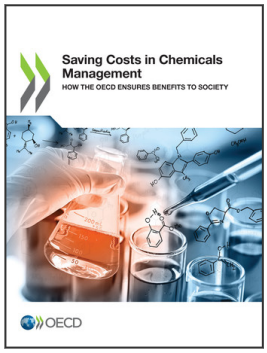

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