European Commission

# Green taxation and other economic instruments

## Internalising environmental costs to make the polluter pay

Written by David Mottershead, Emma Watkins, Tim Gore (IEEP)
Mikael Skou Andersen, Anders Branth Pedersen (Aarhus University)
Kym Whiteoak (Trinomics)
Sander de Bruyn, Robert Vergeer (CE Delft)
Tanzir Chowdhury (Eunomia)
Stijn Van Hummelen, Unnada Chewpreecha (Cambridge Econometrics)

*September 2021*

Institute for European Environmental Policy

*Environment*

**EUROPEAN COMMISSION**

Directorate-General for Environment
Directorate F — Global Sustainable Development
Unit F.1 — Sustainable Development Goals, Green Finance & Economic Analysis

*European Commission*
*B-1049 Brussels*

# Green taxation and other economic instruments

Internalising environmental costs to make the polluter pay

Manuscript completed in September 2021

Final edition

**LEGAL NOTICE**



| | | | | |
|---|---|---|---|---|
| PDF | ISBN 978-92-76-20411-4 | ISSN | doi: 10.2779/326501 | KH-02-21-936-EN-N |

Luxembourg: Publications Office of the European Union, 2021

The authors of this report are grateful to the following for their contributions throughout the duration of the project:

Daniela Russi (IEEP)
Ilia Neudecker (IEEP Associate)
Andreea Beznea, Louis Eklund, Graeme Nichols, Liliana Opinkska, Flavia Sollazzo, Jeroen van der Laan, Henry Varga (Trinomics)
Ignasi Puig Ventosa, Rosaria Chifari, Luís Campos Rodrigues, Sergio Sastre Sanz (ENT Environment & Management)
Amanda Bachaus, Joukje de Vries, Jasper Faber, Dagmar Nelissen, Lisanne van Wijngaarden (CE Delft)
Amy Nicholass, Timothy Elliott, Christina Tsiarta-Panagiotou, Hara Xirou (Eunomia)
Jon Stenning (Cambridge Econometrics)
Boyan Rashev, Ivan Paspaldzhiev, Gabriela Fistis, Denitza Pavlova, Peter Rakovsky, Gabor Raska (Denkstatt)
Janis Brizga (Green Liberty)
Marijan Galović (Galović Consulting)
Lina Šleinotaitė-Budrienė (Ekokonsultacijos)
Helen Poltimaë (SEI Tallinn)
Katja Kavčič Sonnenschein
Peter Hjerp (Ecocentric)
Thomas Bauwens (Fastlane)

# Abstract

This study provides calculations of the external costs associated with air pollution and greenhouse gas emissions, water pollution, waste treatment, water scarcity and biodiversity loss in the EU, and of the extent to which these costs are internalised in taxation and other economic instruments in the EU. The results indicate that to a very large extent, EU polluters are not currently being made to pay. A range of potential environmental taxes and other economic instruments are assessed, and results presented of new macroeconomic modelling that indicates wider use of such measures, with revenues used to lower labour taxation, can produce positive impacts for EU GDP, employment and real household incomes.

# Toolkit for stakeholders

As part of the project, a toolkit for stakeholders[1] was develop to support uptake of market based instruments.

[1] Toolkit for stakeholders https://ec.europa.eu/environment/economy-and-finance/ensuring-polluters-pay_en

# Table of contents

# List of tables

# List of figures



# List of boxes

# List of abbreviations

| | |
|---|---|
| AT | Austria |
| BE | Belgium |
| BG | Bulgaria |
| BOD | Biological Oxygen Demand |
| BRIICS | Brazil, Russia, India, Indonesia, China, South Africa |
| $CH_4$ | Methane |
| CO | Carbon monoxide |
| $CO_2$ | Carbon dioxide |
| CY | Cyprus |
| CZ | Czechia |
| DE | Germany |
| DK | Denmark |
| ECOFIN | Council of European Finance Ministers |
| EE | Estonia |
| EEA | European Environment Agency |
| EL | Greece |
| E-PRTR | European Pollutant Release and Transfer Register |
| ES | Spain |
| ETS | Emissions Trading System |
| EU | European Union |
| EU-27 | 27 EU Member States |
| EUR | Euro (currency) |
| FI | Finland |
| FR | France |
| GDP | Gross domestic product |
| GHG | Greenhouse gas(es) |
| GIS | Geographic information system |
| GJ | Gigajoule(s) |
| ha | Hectare(s) |
| HR | Croatia |
| HU | Hungary |
| HUF | Hungarian forint (currency) |
| IE | Ireland |
| IEA | International Energy Agency |
| IED | Industrial Emissions Directive |
| ILO | International Labour Organisation |
| IMF | International Monetary Fund |
| IT | Italy |
| LT | Lithuania |
| LU | Luxembourg |
| LV | Latvia |
| MBT | Mechanical and biological treatment |
| MS | Member State |
| MT | Malta |
| N | Nitrogen |
| $N_2O$ | Nitrous oxide |
| NACE | Statistical Classification of Economic Activities in the European Community |
| $NH_3$ | Ammonia |
| NL | Netherlands |
| NMVOC | Non-methane volatile organic compounds |
| NOx | Nitrogen oxide |
| OECD | Organisation for Economic Cooperation and Development |
| P | Phosphorus |
| PAYT | Pay as you throw |
| PINES | Policy Instruments for the Environment database |
| PL | Poland |
| PM | Particulate matter |
| PM2.5 | Small particulate matter |
| POP | Persistent organic pollutants |
| PT | Portugal |

| | |
|---|---|
| RBD | River basin district |
| RO | Romania |
| SE | Sweden |
| SEK | Swedish krona (currency) |
| SI | Slovenia |
| SK | Slovakia |
| $SO_2$ | Sulphur dioxide |
| STAN | OECD Structural Analysis Database |
| UK | United Kingdom |
| UN | United Nations |
| VOCs | Volatile organic compounds |

# Executive summary

The polluter pays principle, first recommended by the OECD in 1972[2] and enshrined in the EU Treaty since 1987[3] is at the heart of EU environmental policy. The principle is enacted to ensure that polluting behaviour is changed or – where that does not happen – that polluters compensate society for the costs that they cause. Environmental taxes and other economic instruments, such as trading schemes, are vital to operationalise the principle.

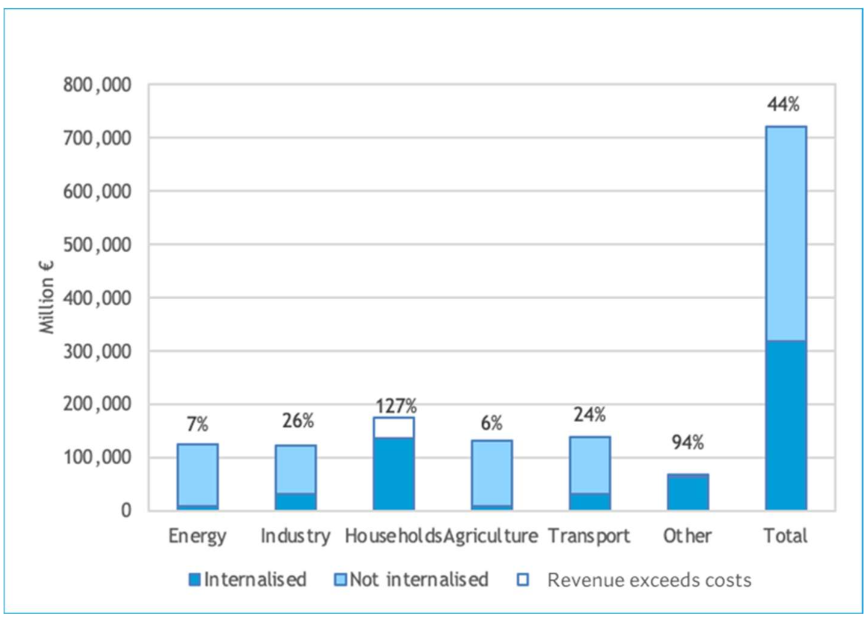
However, while many such measures exist in the EU, this report shows – as recently confirmed by the European Court of Auditors[4] - that many opportunities are still being missed to make EU polluters pay, and that a more rigorous application of the polluter pays principle, implemented through a tax shift from labour to the environment, can also produce positive macroeconomic benefits for the EU economy.

### Are EU polluters paying?

This study compiles estimates of the external environmental costs associated with different sectors of the economy in five areas: air pollution and greenhouse gas emissions (GHGs), water pollution, waste treatment, water scarcity and biodiversity loss. These costs are then compared with the revenues generated from those economic sectors through taxes and other economic instruments, to show their apparent degree of internalisation.

The findings show clearly that EU polluters are not being made to pay in full – across all pollutants, in all Member States and across all sectors of the economy. The evidence is strongest in the case of air pollution and GHGs and water pollution, for which good data on both costs and emissions is available, but more localised evidence about other forms of environmental damage tells the same story.

*Figure E1: Rates of internalisation of the costs of air pollution and GHGs EU-wide*




---

[2] OECD (1972) Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0102

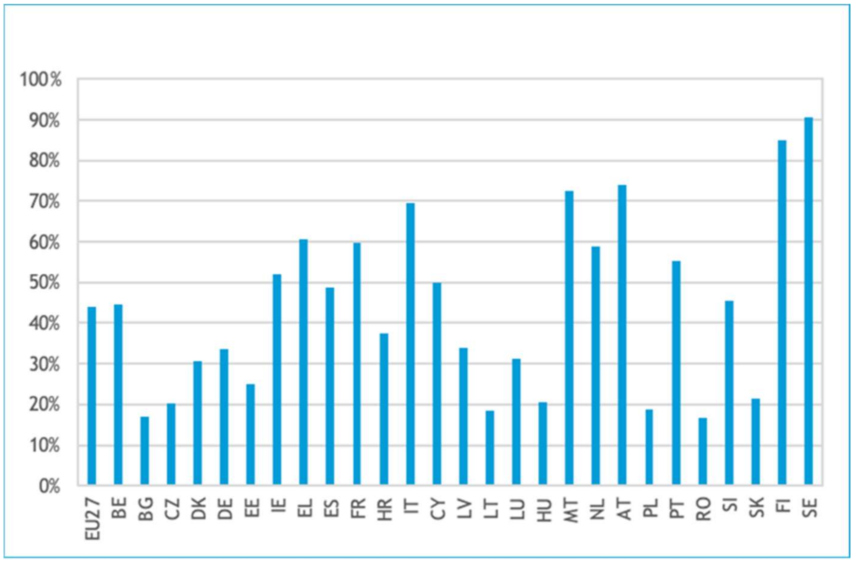
[3] Now article 198 of the Treaty on Further European Union

[4] European Court of Auditors (2021) Special Report 12/2021: The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions, https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=58811

As shown in Figure E1, the external costs of air pollution and GHGs amount to approximately €720 billion per year across the EU – around 5% of EU GDP – of which just 44% is internalised in taxes or economic instruments economy-wide. There is, however, wide variation both between economic sectors and among Member States.

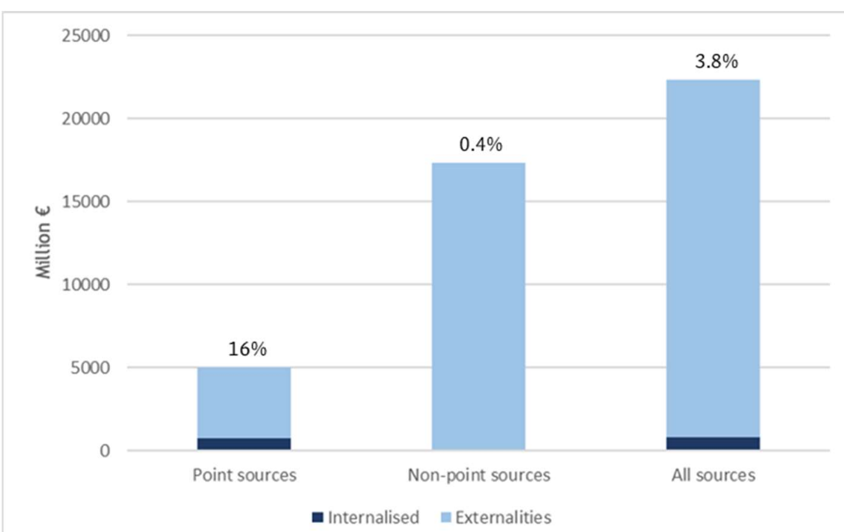
It is notable that households (which in this study includes costs and revenues related to household use of transport fuel in passenger vehicles) both EU-wide and in most Member States contribute substantially more in revenues in relation to their air pollution and GHG costs than do sectors like industry, energy or agriculture. As shown in Figure E2, economy-wide internalisation rates range from 16% in Bulgaria to 91% in Sweden, but 16 of 27 Member States have rates below 50%.

*Figure E2: Rates of internalisation of the costs of air pollution and GHGs by Member State*




In other areas of environmental damage, internalisation rates across the EU are even lower. As shown in Figure E3, the EU-wide internalisation rate of water pollution costs reaches 16% for point sources, linked to households and industry, but is negligible for non-point sources associated with the agriculture sector, which is by far the major source of pollution.

*Figure E3: Rates of internalisation of the costs of water pollution EU-wide*



For the external costs of waste treatment, the internalisation rate is less than 1% across the EU, and less than 5% in most Member States (although it is notable that these figures exclude significant revenues related to waste that are collected by actors other than national governments). As with air pollution and GHG emissions, households face the highest internalisation rate for waste management EU-wide, despite the biggest contribution to external costs relating, by far, to the industry sector.

Estimates for water scarcity and biodiversity loss are harder to derive, because of their complexity and highly site-specific nature. Nonetheless, the case studies assessed in this study suggest that in these areas the internalisation rates are also extremely low. For water scarcity, we found internalisation rates of just 2-3% across our case studies, representing some €3-4 billion of external costs that are unpriced in these five case study regions alone. Similarly, the assessed existing forest charges in Europe are significantly lower than the value of ecosystem services from forests identified in the literature.

Both the cost figures and internalisation rates given here should be considered as under-estimates. It was not possible to derive cost estimates for all pollutants and all impact pathways. If the external costs of water scarcity and biodiversity loss alone were considered across the EU, for example, it is reasonable to assume that total environmental costs would greatly exceed €1 trillion per year. Our revenue estimates, on the other hand, may in some respects overstate how much polluters are paying towards these costs, because in some cases it is not possible to separate user charges from genuine externality taxes.

**How can EU Member States ensure polluters pay?**

There is clearly scope to apply the polluter pays principle more rigorously through an expansion of environmental taxation and other economic instruments in the EU. Many stakeholders have called across the last decade for a shift in taxation from labour to the environment which could help to achieve this. This study therefore explored ten different types of tax or other economic instruments which Member States could consider introducing in order to raise the share of government revenues from environmental taxes and other economic instruments while reducing labour costs.

The ten instruments (which did not include measures to address GHG emissions, which are extensively studied elsewhere) are shown in Figure E4. Key design features of each were established – such as who pays the tax, how rates are set, the regulatory infrastructure needed to support them and how perverse incentives could be avoided – and real-world examples of each identified. These are intended to be a starting point for Member States in approaching environmental tax reform.

*Figure E4: Environmental taxes and other economic instruments investigated in the study*

| Externality | Instrument | Type |
|---|---|---|
| Air pollution (NOx, PM2.5, $NH_3$) | NOx tax | Tax |
| | Tax on domestic biomass burning | Tax |
| | Tradeable livestock rights for NH3 emissions | Trading scheme |
| Water pollution (N, P, BOD) | Pesticides tax | Tax |
| | Nitrogen fertiliser levy | Tax |

| | | |
|---|---|---|
| | Waste water charge | Tax |
| Water scarcity | Externality pricing | Tax |
| | Cap and trade | Trading scheme |
| Waste | Landfill and incineration tax | Tax |
| | Pay as you throw | Tax |
| | Beverage container tax | Tax |
| Biodiversity | Market-based offsetting | Trading scheme |
| | Forest felling charge | Tax |
| | Intensive livestock charge | Tax |
| | Peat tax | Tax |

The study used econometric modelling to assess the macroeconomic impacts from introducing such taxes and economic instruments in EU Member States.

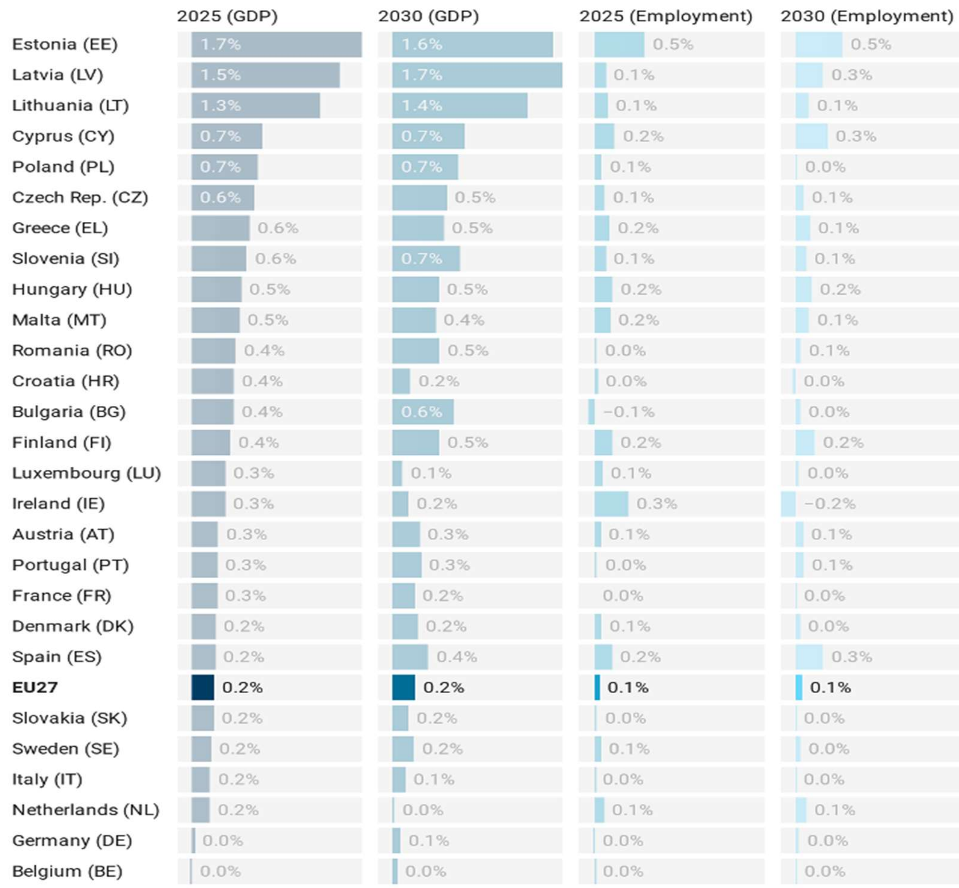
Across all the scenarios modelled, the use of revenues was shown to be a key driver of macroeconomic outcomes. In general, where revenues are used to repay government debt, GDP, employment and real household incomes are all negatively affected. However, where revenues are used to reduce income tax, GDP, employment and real household incomes across the income distribution rise, although in some instances real income may increase slightly more in higher than lower income households.

These findings are confirmed in a stylised EU-wide scenario, in which a basket of ten taxes and economic instruments are introduced in all Member States with revenues used to reduce labour taxes, to give an indication of the magnitude and direction of impact in the EU economy. Overall the results suggest that such a portfolio of polluter pays instruments in combination with a reduction in income taxation could generate positive impacts for GDP, employment and household incomes for the EU economy as a whole

Across the EU, the simulated portfolio of measures raises approximately €30 billion per year by 2030. Using this amount of revenues to reduce income tax generates a net positive GDP impact of €35 billion, offsetting the initial negative impacts of environmental taxation, and creating 140,000 additional jobs. By 2030, the EU's GDP is projected to be around 0.2% higher than GDP in the baseline scenario (business-as-usual projections without additional environmental taxes in the same year), and employment around 0.1% percent higher.

As shown in Figure E5, some variation is nonetheless found among Member States, with GDP increases by 2030 ranging from 0% in some Member States to 1.7% in Latvia, and employment impacts ranging from a 0.2% fall in Ireland to a 0.5% increase in Estonia.

*Figure E5: Impact of a stylised basket of 10 environmental taxes and other economic instruments on growth and jobs across the EU*




As shown in Figure E6, all income groups in all Member States experience an increase in real incomes, although the distributional implications vary to some extent across the Member States:

- In some Member States – including Finland, Greece, Portugal, Austria, Luxembourg, Denmark and Germany, for example – the impact is slightly progressive, with the real income of the lowest income quintile increasing by a higher proportion than that of the highest income quintile;
- In some Member States – including Bulgaria, Czech Republic, Lithuania, France and Italy – the highest and lowest income quintiles see equivalent proportional income rises;
- In some, however – including Estonia, Latvia, Slovenia, Hungary and Poland – the impact is slightly regressive, with the income of the lowest income quintile increasing by a smaller proportion than that of the highest income quintile.

Nonetheless, the general picture is that differences are not marked and whether environmental taxes are progressive or regressive will depend largely on instrument design, including, for example, the extent to which income tax cuts or other revenue recycling options are targeted at lower income earners.

*Figure E6: Impact of a stylised basket of 10 environmental taxes and other economic instruments on real incomes across the EU*

| | All households | First quintile | Second quintile | Third quintile | Fourth quintile | Fifth quintile |
|---|---|---|---|---|---|---|
| Estonia (EE) | 2.8% | 2.6% | 2.5% | 2.6% | 2.8% | 2.9% |
| Latvia (LV) | 2.1% | 1.8% | 1.7% | 1.8% | 2.1% | 2.3% |
| Cyprus (CY) | 1.2% | 1.0% | 1.1% | 1.1% | 1.2% | 1.3% |
| Bulgaria (BG) | 1.1% | 1.2% | 1.2% | 1.1% | 1.1% | 1.2% |
| Slovenia (SI) | 1.1% | 0.9% | 0.8% | 0.9% | 1.1% | 1.2% |
| Hungary (HU) | 1.0% | 0.9% | 1.0% | 1.0% | 1.0% | 1.1% |
| Czech Rep. (CZ) | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% |
| Lithuania (LT) | 0.9% | 0.9% | 0.7% | 0.7% | 0.9% | 0.9% |
| Finland (FI) | 0.8% | 0.9% | 0.9% | 0.8% | 0.9% | 0.8% |
| Malta (MT) | 0.8% | 0.6% | 0.6% | 0.6% | 0.9% | 1.0% |
| Poland (PL) | 0.8% | 0.7% | 0.6% | 0.7% | 0.8% | 0.9% |
| Romania (RO) | 0.7% | 0.5% | 0.5% | 0.6% | 0.7% | 0.8% |
| Slovakia (SK) | 0.6% | 0.5% | 0.5% | 0.5% | 0.6% | 0.7% |
| Greece (EL) | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.5% |
| Portugal (PT) | 0.5% | 0.6% | 0.5% | 0.5% | 0.5% | 0.5% |
| Austria (AT) | 0.4% | 0.5% | 0.5% | 0.4% | 0.5% | 0.4% |
| Luxembourg (LU) | 0.4% | 0.5% | 0.4% | 0.4% | 0.4% | 0.4% |
| Ireland (IE) | 0.4% | 0.3% | 0.4% | 0.4% | 0.4% | 0.4% |
| Sweden (SE) | 0.4% | 0.5% | 0.5% | 0.4% | 0.4% | 0.4% |
| Spain (ES) | 0.3% | 0.4% | 0.4% | 0.3% | 0.4% | 0.3% |
| **EU27** | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Denmark (DK) | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Netherlands (NL) | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Germany (DE) | 0.2% | 0.3% | 0.3% | 0.3% | 0.2% | 0.2% |
| Belgium (BE) | 0.2% | 0.3% | 0.3% | 0.2% | 0.2% | 0.2% |
| France (FR) | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |
| Italy (IT) | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |

*Data for HR not available

The simulated portfolio of taxes is also feasible. The approximately €30 billion they raise (in 2030) compares to €325 billion currently raised from environmental taxes, and the scenario would only raise environmental taxes as a proportion of total tax revenues from 6% to 6.5% - far short of the 10% called for in the European Commission's 2011 Resource Efficiency Roadmap[5] - and would still leave a substantial share of external environmental costs unpriced. This, however, reflects a design choice to initially set instrument rates at relatively low levels which could subsequently be increased over time, an approach which has been

5 Roadmap to a resource efficient Europe. COM (2011) 571 final. https://www.europarl.europa.eu/meetdocs/2009_2014/documents/com/com_com(2011)0571_/com_com(2011)0571_en.pdf

found to be an important element of effective environmental tax reform[6]. We can assume that the macroeconomic effects of larger packages would increase, possibly proportionately, although this would need to be further examined.

Overall this study shows that the external costs of pollution and other forms of environmental damage are substantial, representing a significant burden on society in the EU. While some variation occurs, across economic sectors and Member States, polluters are to a very large extent still not paying for these costs. Numerous examples of polluter pays economic instruments exist across the EU from which lessons can be drawn, and the modelling for this study suggests that their wider application – if carefully designed as part of a shift in the burden of taxation from labour to the environment – can also generate positive macroeconomic benefits.

It is now exactly ten years since the European Commission's call to increase the share of government revenues from environmental taxation. This report, and the accompanying EU polluter pays online toolkit, provide further evidence of the need for EU governments to re-commit to an agenda of environmental tax reforms, and make the polluter pays principle a reality across the EU.

[6] See for example: https://www.oecd.org/env/tools-evaluation/48164926.pdf

# 1. Introduction

Pollution entails the imposition of costs on third parties, which can take many forms. Air pollution, for instance, can lead to human diseases that necessitate healthcare treatment and to shorter or impaired lives. The polluter pays principle, first recommended by the OECD in 1972[7] and enshrined in the EU Treaty since 1987[8] is at the heart of EU environmental policy. Application of the principle aims to ensure that polluting behaviour is changed or – where that does not happen – that polluters compensate society for the costs that they cause.

It has long been recognised that taxes and other market-based or economic instruments, such as trading schemes, have a role to play in operationalising the polluter pays principle. Taxes can be a means to raise government revenue to compensate society for the damage caused by pollution, as well as a means of deterring that damage from happening in the first place. Other market-based instruments – whilst not necessarily raising revenue – can also ensure that polluting activity results in a cost to the polluter.

The use of such taxes, charges and other economic instruments in the EU goes back decades. For example, fuel excise duties have existed in some European countries since the early 20th century; Sweden's tax on emissions of Nitrous Oxides were first introduced some thirty years ago; whilst at EU level the Emissions Trading Scheme (ETS) for greenhouse gases was introduced in 2005. Such measures nonetheless remain under-used. As recently confirmed by the European Court of Auditors[9] and as the analysis in this report demonstrates, many opportunities are being missed to make EU polluters pay.

The European Commission's 2011 Resource Efficiency Roadmap[10] noted that some Member States collected more than 10% of their revenue in environmental taxes and proposed a major shift from labour taxes to less distorting environmental taxation by 2020. This shift did not take place: in 2020 environmental taxes constituted just 5.9% of all Member State revenue from taxes and social contributions[11]. Of these, more than three quarters were taxes on energy, while just a fraction were taxes on pollution or the use of resources[12], with large variations across the Member States.

Numerous stakeholders have echoed the call for environmental tax reform over the last decade. For example:

- The European Environment Agency declared in 2012 that European governments could "simultaneously reduce income tax, increase innovation and cut pollution by

[7] OECD (1972) Recommendation of the Council on Guiding Principles concerning International Economic Aspects of Environmental Policies, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0102

[8] Now article 198 of the Treaty on Further European Union

[9] European Court of Auditors (2021) Special Report 12/2021: The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions, https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=58811

[10] Roadmap to a resource efficient Europe. COM (2011) 571 final. https://www.europarl.europa.eu/meetdocs/2009_2014/documents/com/com_com(2011)0571_/com_com(2011)0571_en.pdf

[11] Source: Eurostat environmental tax statistics, https://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_tax_statistics

[12] Eurostat's definition of environmental taxes includes four main categories: energy (including fuel for transport), transport (excluding fuel for transport), pollution (including e.g. emissions to air and water, pesticides, fertilizers, waste and noise) and resources (including water abstraction, timber, hunting/fishing, raw material extraction and land use change). See: https://ec.europa.eu/eurostat/cache/metadata/en/env_ac_tax_esms.htm

introducing well-targeted environmental taxes and recycling the revenues back into the economy".[13]

- The OECD in an October 2020 blog post pointed out that "well-designed tax policy reinforces green stimulus and additionally aligns traditional forms of stimulus with decarbonisation objectives".[14]
- In March 2021 the European Trade Union Congress called for a Europe-wide carbon tax as part of a package with regulatory and other measures to tackle the climate crisis.
- The 2021 Commission Communication on Business Taxation for the 21st Century acknowledged: "A tax system that supports the green transition will be a vital tool to achieve the objectives of the European Green Deal. Tax measures will have to go hand in hand with other environmental pricing instruments as well as regulatory measures, while taking distributional impacts into due account to ensure a just transition."[15]
- Commissioner and Executive Vice-President Dombrovskis issued a statement following the May 2021 Informal Council of European Finance Ministers (ECOFIN) in which he reported Council agreement that green taxes can "encourage a sustainable use of resources, reduce waste and pollution, bring economic, social and health benefits, and help to broaden the tax base and encourage the shift away from labour taxes".[16]
- Most recently, the European Court of Auditors' July 2021 report raised concerns that the polluter pays principle is inconsistently applied across EU environmental policies, leaving the taxpayer and not the polluter covering some of the costs created by pollution[17].

The purpose of this report is to contribute new evidence in support of the greater use by Member States of environmental taxation and other economic instruments. Sections 2 and 3 present comparisons of monetary estimates of the costs imposed by different types of pollution by different sectors of the economy with the environmental taxes or charges those sectors pay. Section 4 explores a range of existing (and a few potential new) taxes which Member States could use to close the gap, alongside other instruments which can be used to strengthen the price signals faced by polluters. Finally, section 5 describes the results of macroeconomic modelling to show that shifting from labour taxes to a package of environmental taxes would be good for GDP, jobs and real household income.

In addition to this report, and building on the evidence collected on existing instruments, an online stakeholder toolkit has been developed. The aim of the toolkit is to support the dissemination among a wider range of stakeholders of information on economic instruments

[13] EEA (2012) Environmental tax reform: increasing individual incomes and boosting innovation, https://www.eea.europa.eu/highlights/environmental-tax-reform-increasing-individual

[14] OECD (2020) Green budgeting and tax policy tools to support a green recovery, https://www.oecd.org/coronavirus/policy-responses/green-budgeting-and-tax-policy-tools-to-support-a-green-recovery-bd02ea23/

[15] Communication from the Commission to the European Parliament and the Council on Business Taxation for the 21st Century, COM/2021/251 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0251&qid=1625583714130

[16] Remarks by Executive Vice-President Valdis Dombrovskis at the ECOFIN Press Conference May 21 2021, https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_21_2641

[17] ECA (2021) Special Report. The Polluter Pays Principle: Inconsistent application across EU environmental policies and actions, https://www.eca.europa.eu/Lists/ECADocuments/SR21_12/SR_polluter_pays_principle_EN.pdf

to make polluters pay in the EU. The results of the study will also feed into the European Commission's flagship initiative on Greening taxes[18], through which Member States may request technical support in greening their budgets and applying the polluter pays principle through environmental fiscal reforms.

## 1.1. Scope and methodological approaches

This is the final report of a study carried out for the European Commission and funded by the European Parliament[19] to assess the extent to which polluters in the EU are paying for the external costs of pollution or environmental damage, and to explore options for increasing the scope of economic instruments to make polluters pay. The report focuses on five types of environmental cost, related to:

- Air pollution and greenhouse gas (GHG) emissions;
- Water pollution;
- Waste management;
- Water scarcity; and
- Biodiversity loss.

The report only considers ways of making polluters pay more towards the costs they impose on society - it does not examine the case for removing environmentally harmful subsidies, which is the subject of a separate workstream funded by the European Parliament[20].This report summarises the work undertaken by the study team in three main stages, as follows.

### 1.1.1. Estimating external environmental costs

Firstly, the study investigated the external environmental costs under the five thematic areas mentioned above. Rather than creating new cost estimates, the study relied on literature reviews to derive cost estimates per unit, drawing from a range of methodological approaches appropriate to each thematic area and type of pollutant.

The impact pathways literature was used to identify cost per unit estimates for air pollution (which were also used in the calculation of the external costs of waste management) and for water pollution, with value transfer methods used to provide Member State-specific estimates.

The waste management costs related to air pollution were complemented with estimates of the disamenity costs of landfill, using hedonic pricing methods. Estimates for the costs of GHG emissions were based on the literature on abatement costs, given the global and long-term nature of, and high uncertainties around, the extent of climate-related costs.

Member State and EU-wide total cost estimates in these areas were then derived by multiplying the cost per unit estimates by data on emissions to air and water from Eurostat and other relevant databases. The Eurostat air pollution and GHG emissions datasets used can be disaggregated according to the NACE Rev. 2 classification of economic sectors, on

---

[18] See https://ec.europa.eu/info/sites/default/files/b1-greening_taxes.pdf

[19] European Commission contract 07.027745/2019/801533/SER/ENV.F.1. Mapping objectives in the field of environmental taxation and budgetary reform: Internalisation of environmental external costs, funded via the European Parliament's PA 09 18 01: Preparatory action — Operationalising capacity building for programmatic development and mapping objectives in the field of environmental taxation and budgetary reform.

[20] PA 09 18 01 - 07 02 77 45: Preparatory action — Operationalising capacity building for programmatic development and mapping objectives in the field of environmental taxation and budgetary reform: EHS

which basis a simplified sectoral disaggregation of costs was made between households, industry, energy, transport, agriculture and other sectors (see section 3.1 for more details).

It is worth noting that in this study, air pollution and GHG emissions from personal use of passenger vehicles (and by extension, taxes related to passenger vehicle fuel consumption) are allocated to the ‘household’ sector, not the ‘transport’ sector. With regard to waste management, the ‘transport’ sector is combined with the ‘other’ sector, given its negligible contribution to waste.

A similar sectoral disaggregation was followed for water pollution, where results are disaggregated into point sources (relating to households and industry, which in this case includes energy) and non-point sources, namely agriculture. Other sectors, including transport, were not considered here given their negligible contributions to water pollution.

Given their complexity and the highly site-specific nature of the external costs, cost estimates for water scarcity and biodiversity loss were drawn from case studies using ecosystem valuation approaches, with the latter focusing on ecosystem services provided by forests alone. No EU-wide or sectoral cost estimates have therefore been made in these areas.

Further details on the specific methods and headline findings related to the external costs in each area are given in section 2 and the report’s Annexes.

### 1.1.2. Estimating rates of internalisation of environmental costs

The study also scoped taxes and other economic instruments that can be considered to address the external costs related to the five thematic areas, as described in Box 1 below, with a view to estimating the apparent degree of internalisation of external environmental costs in taxation and other economic instruments in the EU.

**Box 1: Economic instruments considered within the scope of this study**

- **Taxes:** Compulsory payments levied by governments on tax bases deemed of particular relevance e.g. waste generation, pollution or resource use. They are unrequited in the sense that the benefits provided by government to the taxpayers are not normally in proportion to their payments[21];
- **Other user charges and fees:** Compulsory payments to government/other bodies in return for an identified service (e.g. water supply, waste management), access to a resource (e.g. land use, fisheries) or cost (e.g. emissions/pollution, waste generation). They are meant to partially or fully cover a specific cost[22];
- **Levy:** The term levy is a hybrid of tax and user charge based on the polluter-pays principle (*Abgaben* in German, *redevances* in French, *heffingen* in Dutch, *afgifter* in Danish etc). Collective benefits are provided (reduced external costs) but they are not necessarily proportional to the payment made;
- **Tradable permits/quotas** to pollute or exploit resources[23];
- **Deposit refund schemes** to increase recycling through encouraging people to return beverage containers or other recyclable items; and
- **Offsetting schemes** which make those who damage the environment bear the cost of replacing it elsewhere.

NB The distinction between taxes, charges and fees is not always well established; a tax based on measured emissions is often described as a charge[24], and different countries may use different terms to describe similar instruments, or even use them interchangeably.

Other economic instruments that are outside the scope of this study include subsidies, grants and risk transfer mechanisms such as environmental liability regimes.

Revenues from existing instruments were derived primarily from the Eurostat dataset on environmental taxes[25], and complemented by the OECD PINES database[26] and expert input from the study team. The revenues from the different instruments were allocated by the study team to one of the five themes assessed in the study, and disaggregated by sectors using the NACE Rev. 2 classification to match the sectors identified in the external cost estimates.

[21] Based on OECD (2001) Environmentally Related Taxes in OECD Countries: Issues and Strategies. Paris, OECD (2013) Climate and carbon – Aligning prices and policies, Environment Policy Paper, October 2013, No.1, http://www.oecd-ilibrary.org/docserver/download/5k3z11hjg6r7.pdf?expires=1400775606&id=id&accname=guest&checksum=DE75F73C541A7C2833BF91064B683C47

[22] Based on European Environment Agency (2005) Market Based Instruments in Environmental Policy in Europe. EEA Technical Report No 8/2005. ISBN 92-9167-782-5, https://www.eea.europa.eu/publications/technical_report_2005_8

[23] J.E. Milne and M.S. Andersen (2012) Handbook of research on environmental taxation, Edward Elgar.

[24] Barde, J.P. and Owens, J. (1993) The greening of Taxation. OECD Observer, Vol. a, 1993

[25] Eurostat, Tax revenue statistics, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tax_revenue_statistics

[26] OECD, Database on Policy Instruments for the Environment PINE database portal, https://pinedatabase.oecd.org/

This allowed for calculation of the ratio of revenues from economic instruments to the external costs of air pollution and GHG emissions, water pollution and waste treatment on an EU-wide, Member State and sectoral basis, according to the following formula:

$$Apparent\ degree\ of\ internalisation_{i.j,k} = \frac{Revenue\ economic\ instruments_{i,j,k}}{External\ costs_{i,j,k}}$$

where the suffixes i, j and k denote sector, MS and environmental theme respectively.

We refer to this as the apparent degree of internalisation, given the methodological limitations summarised below and given that these are estimates of how total tax revenues relate to total environmental damage, without consideration of the marginal tax rates and marginal damage costs, nor of which actor pays the tax. It therefore does not necessarily follow that even a 100% apparent internalisation rate implies that all polluters (even in a particular sector) are presented with an appropriate price signal. The estimated rates nonetheless give a simple and clear indication of the extent to which polluters are paying for environmental damage in particular sectors and Member States.

Internalisation rates for water scarcity and biodiversity loss (based on the ecosystem services provided by forests alone) were instead calculated solely for the assessed case studies. In each case, an attempt was made to estimate total revenues from identified instruments in the case study region, which were then compared with the available estimates of potential external costs to reach broad-brush conclusions about the extent of internalisation in those regions and across the EU.

Further details on the method and headline findings related to the assessment of internalisation rates are given in section 3 and the report's Annexes.

### 1.1.3. Assessing options for expanding polluter pays instruments

The study also included an analysis of the principal design features, potential impacts, strengths and weaknesses and implementation challenges of a range of economic instruments already in place within (and in some cases outside) EU Member States, and some additional instruments with the potential to support implementation of the EU environmental *acquis*. The analysis did not, however, include measures explicitly designed to address GHGs, which have been widely studied in other reports. A summary of the analysis is provided in section 4.

On the basis of this analysis, scenarios were built for econometric modelling of the macroeconomic impacts of a range of economic instruments which aim to make the polluter pay. Instrument and Member State-specific scenarios were complemented with a stylised EU-wide scenario based on a package of ten instruments, covering this study's five thematic areas, applied across the EU to give a broad indication of the direction and magnitude of the impacts on GDP, employment, real household incomes and trade.

Further detail on the modelling approach, scenarios and headline results is presented in section 5 and Annex 6.

### 1.1.4. Methodological limitations

It is important to note some limitations to the study methodology.

Firstly, the analysis of external costs is partial. Environmental costs are themselves only a sub-set of all external costs. For example in the transport sector costs related to accidents, congestion (time loss) and noise are also considered external costs[27]. Therefore it is important to note that the degrees of internalisation presented in this study refer to environmental costs only. This means that even when the apparent degree of internalisation is presented as 100%, this does not imply that all external costs are covered.

Furthermore, it has not been possible to estimate all environmental costs. In each of the thematic areas, potentially significant impacts have not been included. For example, air pollution cost estimates do not include all toxic substances; water pollution costs do not reflect some important impact pathways, including for example on fish; waste treatment estimates do not reflect any costs of pollution in soils; and biodiversity costs are limited solely to an assessment of forests. Alternative methods to establishing the costs of GHG emissions, may lead to substantially higher estimates than used here.[28] Undoubtedly, therefore, the cost estimates provided here should be considered as conservative.

With regard to the revenues from polluter pays economic instruments, it is likely that at least some relevant instruments have been missed, despite our efforts to complement gaps in the principal databases used with expert inputs. And as described above, it is a limitation that we cannot show the point of application of polluter pays economic instruments in terms of the specific actors within a sector that will be subject to a price signal. It has also not been possible to distinguish in some cases between revenues that are explicitly related to environmental externalities as opposed to other types of externality, which may imply a higher rate of internalisation of environmental costs.

Various limitations should be noted also with regard to the modelling results, as with all modelling exercises, which are further elaborated in section 5 and Annex 6. The modelling results should consequently be interpreted as indicative of the direction and order of magnitude of likely macroeconomic impacts and are sensitive to the particular scenario design choices.

[27] CE Delft (2019) Handbook on the External Costs of Transport, https://cedelft.eu/publications/handbook-on-the-external-costs-of-transport-version-2019/

[28] See for example the European Investment Bank's assumed shadow carbon price of €250/tonne by 2030. https://www.eib.org/attachments/thematic/eib_group_climate_bank_roadmap_en.pdf

# 2. The cost of pollution

One widely used approach to valuing the cost of pollution is to consider the pathways by which pollution leads to impacts, then to calculate the cost of those impacts. This approach is possible for two of the forms of environmental damage considered in this study – air and water pollution.

Air pollution, for example, causes damage to human health which can be quantified using figures for the cost of treatment and for quality life years lost due to additional mortality and morbidity. A wide body of academic literature exists from which such values can be drawn for air and water pollution and this is used below to establish overall figures for costs as well as a breakdown of the contribution of different sectors of the economy, as explained below.

A different approach is needed to establish the costs of the other forms of environmental damage which are considered, although monetary valuation is still relevant. For example, the costs of GHGs are assessed based on the cost of abatement, because of the global, long-term, somewhat unknown and uncertain forms of impacts, as explained below. Harm to biodiversity, for example, is also difficult to assess through an impact pathway approach because biodiversity is complex and so many of the pathways and impacts are not well understood. Instead, the cost of harm to biodiversity can be approached by placing a value on the ecosystem services it provides.

## 2.1. The costs of air pollution and GHGs

The principal impacts through air relate to air pollution arising from Particulate Matter (PM) 10/2.5, Non-methane volatile organic compounds (NMVOC), $SO_2$, NOx and $NH_3$, and to GHGs, in particular $CO_2$. Emissions of other toxic substances (e.g. heavy metals, POP) also have an impact on health and the environment but are not considered further in this study. The assessed air pollutants cause impacts on human health, ecosystems, buildings and materials as briefly described below:

- **Human health** impacts arise primarily (either directly or through chemical transformation in the atmosphere) from emission of particulate matter and NOx, $SO_2$, $NH_3$ and NMVOC which cause cancer, respiratory and cardiovascular diseases, and high tropospheric concentrations of the secondary pollutant ozone (formed from reactions of NOx, CO and VOCs) or $NO_2$, formed from NOx, which cause and/or exacerbate respiratory conditions such as chronic obstructive pulmonary disease and asthma. The European Environment Agency (EEA) has estimated[29] that in 2018 air pollution by PM 2.5 alone in the 27 Member States and the United Kingdom was responsible for 379,000 premature deaths, with nitrogen dioxide linked to 54,000 premature deaths and tropospheric ozone to 19,400.
- In addition to human health, air pollution can also have significant impacts on **ecosystems**. Air pollutants lead to eutrophication and acidification of soils which negatively impact biodiversity and crop yields. Moreover, elevated ground-level ozone levels also cause damage to crops and ecosystems.
- Acidifying substances may lead to corrosion and damage to **cultural heritage**, increasing maintenance costs. PM2.5/PM10 concentrations can also damage **buildings**. Because of the catalytic action of soot particles, this pollution accelerates the erosion of building surfaces. Finally, elevated ozone concentrations at ambient levels cause paint to wear off resulting in higher maintenance costs.

[29] EEA (2020) Air Quality in Europe – 2020 report, https://www.eea.europa.eu//publications/air-quality-in-europe-2020-report

The accumulation of GHGs in the atmosphere also results in significant impacts on these same endpoints as a result of climate change impacts. For example, an increase in the frequency and/or severity of extreme weather events such as heatwaves can lead to an increase in hospital appointments and mortality due to heat stress, as well as damaging ecosystems, biodiversity and infrastructure such as roads. A range of impacts may similarly be identified in relation to other climate change impacts, such as changes in average precipitation, sea-level rise, glacier retreat or ocean acidification.

The relationships between individual air pollutants and GHGs, the sectors responsible for their emissions, and their impacts are summarised in Table 1 below.

**Table 1: Air pollutants and GHG and their impact pathways**

| Pollutant | Main Sector(s)[30,31] | Endpoint(s) [32] | Midpoint(s)[33] |
|---|---|---|---|
| Nitrogen oxides ($NO_x$) | Transport<br>Energy<br>Households (heating in particular) | Human health<br>Ecosystems<br>Materials/buildings | Smog formation<br>Particulates formation<br>Acidification<br>Eutrophication |
| Particulate matter (PM2.5) | Energy<br>Industry<br>Transport<br>Households (heating) | Human health<br>Materials/buildings | Particulates formation |
| Non-methane volatile organic matter (NMVOC) | Industry<br>Households (product use) | Human health<br>Ecosystems<br>Materials/buildings | Smog formation |
| Sulphur dioxide ($SO_2$) | Energy<br>Industry<br>Households (heating) | Human health<br>Ecosystems<br>Materials/buildings | Smog formation<br>Particulates formation<br>Acidification<br>Eutrophication |
| Ammonia ($NH_3$) | Agriculture | Human health<br>Ecosystems | Particulates formation<br>Acidification<br>Eutrophication |
| GHG: Carbon dioxide ($CO_2$) | All sectors | Human health<br>Ecosystems<br>Materials/buildings | Climate change |
| GHG: Methane ($CH_4$) | Agriculture | Human health | Climate change |

[30] National Emission reduction Commitments Directive emissions data viewer 1990-2016 (European Environment Agency website, update 12 July 2018)

[31] Greenhouse gas emission statistics – air emissions accounts (Eurostat website, update May 2018)

[32] Roy, R. and N. Braathen (2017), "The Rising Cost of Ambient Air Pollution thus far in the 21st Century: Results from the BRIICS and the OECD Countries", OECD Environment Working Papers, No. 124, OECD Publishing, Paris.; this accounts for human life years lost only.

[33] Source of midpoints: CE Delft (2018) Environmental Prices Handbook 2017, https://cedelft.eu/publications/environmental-prices-handbook-2017/

| | | | |
|---|---|---|---|
| | Mining, energy | Ecosystems<br>Materials/buildings | Smog formation |
| Nitrous oxide ($N_2O$) | Agriculture<br>Industry | Human health<br>Ecosystems<br>Materials/buildings | Ozone layer depletion<br>Climate change |

*Source: own analysis*

The study reviewed a wide range of national and international reports which have calculated values for the costs of air pollution and GHGs (see Annex 1). From this material, separate approaches were identified to estimate the costs of air pollution and of GHGs.

For air pollution, appropriate central values were found from studies estimating damage costs related to the endpoints described above. For human health impacts, for example, this includes costs related to chronic and acute mortality, respiratory and cardiovascular hospital admissions, infant mortality, loss of working days, and restricted activity days (see Annex 1 for further details[34]).

These central values are expressed in costs per kg per year of each pollutant, and differentiated by Member State according to a value transfer approach methodology (see Annex 1 for further details[35]) to reflect factors such as differing income and population density, and in some cases differentiated by both pollutant and the emitting sector(s) since the height at which emissions occur can affect the impact pathway. The resultant values obtained for air pollution costs are shown in Table 2.

With regard to estimating the costs of GHGs, a different approach was taken. Climate change costs are widely understood to be global, long-term, wide-ranging (not all impacts being well-understood) and highly uncertain (in particular in relation to the consequences of climate 'tipping points'). As a result, this study uses estimates based on the costs of abatement of GHGs consistent with achieving the objective of the Paris Agreement. Based on an assessment of a range of studies, a central value of €100/tonne is used for emissions through to 2030 (see Annex 1 for more detail[36]).

---

[34] See also: CE Delft (2019) Handbook on the External Costs of Transport, https://cedelft.eu/publications/handbook-on-the-external-costs-of-transport-version-2019/

[35] See also: CE Delft (2019) Handbook on the External Costs of Transport, https://cedelft.eu/publications/handbook-on-the-external-costs-of-transport-version-2019/

[36] See also: CE Delft (2019) Handbook on the External Costs of Transport, https://cedelft.eu/publications/handbook-on-the-external-costs-of-transport-version-2019/

**Table 2: Costs per kg/year of air pollutants by pollutant, sector and Member State (€, 2016 prices)**

| Pollutants | $NH_3$ | NMVOC | $SO_2$ | NOx | NOx | NOx | PM2.5 | PM2.5 | PM2.5 |
|---|---|---|---|---|---|---|---|---|---|
| *Sectors* | *All* | *All* | *All* | *Agriculture* | *Transport* | *Average* | *Transport* | *Electricity* | *Average* |
| EU-27 + UK average | 17.5 | 1.2 | 10.9 | 12.6 | 16.3 | 14.8 | 127.7 | 19.4 | 38.7 |
| Austria | 27.8 | 2.3 | 16.2 | 24.3 | 31.8 | 28.7 | 174.9 | 26.8 | 53.7 |
| Belgium | 38.2 | 3.6 | 17.1 | 15.1 | 19.0 | 18.0 | 157.8 | 34.6 | 81.1 |
| Bulgaria | 5.6 | 0.0 | 4.2 | 5.9 | 8.0 | 7.0 | 73.2 | 7.1 | 9.2 |
| Croatia | 17.9 | 0.9 | 8.8 | 11.4 | 14.5 | 13.3 | 106.8 | 16.2 | 21.2 |
| Cyprus | 3.8 | 0.0 | 7.8 | 4.5 | 6.4 | 5.4 | 40.0 | 10.9 | 14.0 |
| Czechia | 27.4 | 1.1 | 11.6 | 14.8 | 19.5 | 17.4 | 144.7 | 22.6 | 35.0 |
| Denmark | 14.0 | 1.5 | 11.1 | 9.6 | 12.4 | 11.3 | 142.2 | 13.9 | 25.8 |
| Estonia | 10.5 | 0.3 | 6.2 | 3.4 | 4.2 | 3.9 | 58.1 | 5.9 | 8.4 |
| Finland | 7.0 | 0.4 | 5.8 | 3.5 | 4.2 | 3.9 | 112.8 | 4.8 | 10.1 |
| France | 15.4 | 1.5 | 15.0 | 16.2 | 20.3 | 19.0 | 156.5 | 25.1 | 42.9 |
| Germany | 28.1 | 1.8 | 17.8 | 21.6 | 27.8 | 25.5 | 154.5 | 37.6 | 68.5 |
| Greece | 4.8 | 0.3 | 6.8 | 3.1 | 4.2 | 3.6 | 125.9 | 7.7 | 14.6 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hungary | 18.9 | 0.8 | 10.9 | 15.8 | 20.5 | 18.6 | 124.8 | 20.3 | 33.0 |
| Ireland | 4.1 | 1.7 | 13.6 | 10.1 | 13.5 | 12.1 | 248.0 | 13.6 | 29.6 |
| Italy | 21.6 | 1.1 | 14.0 | 15.1 | 18.4 | 17.7 | 141.7 | 21.1 | 46.2 |
| Latvia | 8.7 | 0.4 | 5.6 | 4.4 | 5.5 | 5.1 | 107.6 | 5.7 | 9.6 |
| Lithuania | 7.9 | 0.6 | 7.3 | 7.1 | 9.6 | 8.4 | 101.3 | 7.7 | 13.9 |
| Luxembourg | 60.0 | 6.2 | 31.7 | 38.4 | 48.3 | 45.7 | 212.0 | 63.7 | 111.8 |
| Malta | 6.4 | 0.4 | 5.0 | 1.4 | 1.9 | 1.7 | 44.8 | 6.2 | 8.5 |
| Netherlands | 30.0 | 2.8 | 21.5 | 15.3 | 19.8 | 18.2 | 144.1 | 37.3 | 81.3 |
| Poland | 14.4 | 0.7 | 9.0 | 8.9 | 11.2 | 10.4 | 104.1 | 16.3 | 27.9 |
| Portugal | 4.3 | 0.5 | 5.1 | 1.7 | 2.4 | 2.0 | 112.5 | 5.2 | 21.2 |
| Romania | 9.4 | 0.5 | 8.1 | 11.2 | 15.4 | 13.3 | 86.8 | 12.4 | 20.9 |
| Slovakia | 24.4 | 0.7 | 11.1 | 14.7 | 19.5 | 17.3 | 76.9 | 18.4 | 28.3 |
| Slovenia | 23.8 | 1.2 | 10.0 | 13.7 | 17.5 | 15.9 | 63.9 | 16.0 | 26.7 |
| Spain | 6.4 | 0.7 | 7.9 | 5.1 | 7.0 | 6.0 | 132.5 | 9.8 | 20.3 |
| Sweden | 10.6 | 0.7 | 6.8 | 6.0 | 7.4 | 6.9 | 127.0 | 6.2 | 17.6 |

*Source: own calculations based on national and international studies (see Annex 1)*

Multiplying these values for air pollutants and GHGs by total annual emissions (from Eurostat's database of air pollutant and GHG emissions) in 2016 in each Member State gives the following estimated total annual costs as shown in Table 3. Overall, for the EU-27 the annual costs are estimated to be €720 billion, around 5% of EU GDP, more than half of which is attributed to GHGs.

The Eurostat databases of air pollutant and GHG emissions includes datasets which are disaggregated by the NACE Rev. 2 classification of economic sectors. These were used to facilitate the disaggregation of internalisation rates according to six economic sectors used in this study, as described in section 3.1.

**Table 3: Cost of air pollution and GHG by pollutant and Member State (annual; in € million)**

| | $NH_3$ | NMVOC | $SO_2$ | NOx | PM2.5 | GHG- (CO2-eq) | Total |
|---|---|---|---|---|---|---|---|
| EU 27 | 63,742 | 8,039 | 33,733 | 143,217 | 68,664 | 402,752 | 720,152 |
| Austria | 1,887 | 263 | 228 | 3,818 | 1,027 | 7,335 | 14,558 |
| Belgium | 2,578 | 383 | 696 | 3,319 | 2,067 | 11,824 | 20,867 |
| Bulgaria | 285 | 0 | 445 | 987 | 401 | 5,909 | 8,024 |
| Croatia | 666 | 62 | 131 | 749 | 448 | 2,439 | 4,492 |
| Cyprus | 24 | 0 | 129 | 84 | 21 | 879 | 1,130 |
| Czechia | 1,967 | 210 | 1,287 | 2,904 | 1,515 | 11,908 | 19,790 |
| Denmark | 1,054 | 203 | 6,073 | 11,477 | 5,970 | 8,771 | 33,547 |
| Estonia | 104 | 8 | 244 | 209 | 127 | 2,041 | 2,734 |
| Finland | 222 | 38 | 243 | 710 | 407 | 6,189 | 7,808 |
| France | 9,345 | 1,425 | 2,887 | 19,026 | 8,491 | 47,110 | 88,284 |
| Germany | 19,199 | 1,972 | 6,021 | 46,232 | 18,105 | 97,746 | 189,275 |
| Greece | 311 | 44 | 409 | 952 | 932 | 9,170 | 11,818 |
| Hungary | 1,647 | 116 | 252 | 2,565 | 1,731 | 6,457 | 12,766 |
| Ireland | 479 | 181 | 187 | 1,344 | 489 | 7,122 | 9,803 |
| Italy | 8,451 | 1,020 | 4,270 | 17,139 | 11,563 | 44,565 | 87,008 |
| Latvia | 143 | 18 | 21 | 235 | 207 | 1,280 | 1,904 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lithuania | 239 | 28 | 118 | 832 | 229 | 2,809 | 4,255 |
| Luxembourg | 334 | 69 | 75 | 1,288 | 235 | 1,011 | 3,012 |
| Malta | 7 | 1 | 9 | 10 | 4 | 347 | 378 |
| Netherlands | 3,876 | 714 | 860 | 7,426 | 1,442 | 21,707 | 36,024 |
| Poland | 4,207 | 469 | 5,343 | 8,871 | 4,630 | 41,235 | 64,755 |
| Portugal | 245 | 91 | 245 | 338 | 1,356 | 6,704 | 8,979 |
| Romania | 1,572 | 111 | 889 | 3,707 | 2,459 | 11,972 | 20,710 |
| Slovakia | 677 | 67 | 292 | 1,152 | 551 | 4,215 | 6,954 |
| Slovenia | 450 | 38 | 47 | 670 | 332 | 1,850 | 3,386 |
| Spain | 3,209 | 418 | 1,857 | 5,397 | 2,667 | 33,998 | 47,544 |
| Sweden | 564 | 101 | 477 | 1,776 | 1,263 | 6,167 | 10,347 |

*Source: own calculations based on Table 2 and Eurostat data (env_ac_ainah_r2)*

## 2.2. The costs of water pollution

Water pollution stems from both point and non-point (i.e. diffuse) sources. While non-point sources mostly refer to the agricultural sector, point sources refer to urban waste water treatment (households, business and some industry) as well as direct industrial discharges (some industries are connected to urban waste water treatment plants, with so-called indirect discharges, while others have direct discharges to surface waters).

The study considered water pollution by active nitrogen and phosphorus (including the toxic metal cadmium contained in mineral phosphorus), for which good data exists. These pollutants arise primarily from non-point sources and in particular, agriculture. The principle impacts of these pollutants are:

- **Damage to ecosystems** and **loss of amenity** to householders with waterfront properties and recreational water users resulting from eutrophication[37]; and
- **Human health** impacts from cancers caused by nitrite pollution of drinking water as well as impacts such as osteoporosis from the ingestion of cadmium in food grown using P fertilisers.

Methods to calculate values for the cost per kg/year of leaching from surplus nitrogen and phosphorus (that which is applied but not taken up by plants) were found in literature as described in Annex 3 and estimates derived for Member States. Good data exists to

[37] Eutrophication is the excessive richness of nutrients in a lake or other body of water, often caused by run-off from the land, causing the dense growth of plant life.

establish the impact of excess nitrogen leaching on sight depth in surface water which is in turn a satisfactory proxy for both damage to ecosystems and loss of amenity[38]. Health impacts of nitrogen contamination of drinking water are also costed. The costs of pollution with nitrogen and phosphorus nutrients vary from Member State to Member State, as shown in Table 4, due to differences in population density, proximity to surface and coastal waters and sources of drinking water supply.

**Table 4: Costs in €/kg/year of water pollution by pollutant and Member State**

| Member State | BE | BG | CZ | DE | DK | EE | IE | EL | ES |
|---|---|---|---|---|---|---|---|---|---|
| €/kg N surplus | 6.00 | 0.20 | 1.40 | 2.33 | 2.99 | 0.45 | 1.23 | 0.77 | 0.85 |
| €/kg P | 4.35 | 0.32 | 0.94 | 2.02 | 2.54 | 0.24 | 0.93 | 0.73 | 0.9 |

| Member State | FR | HR | IT | CY | LV | LT | LU | HU | MT |
|---|---|---|---|---|---|---|---|---|---|
| €/kg N surplus | 1.75 | 1.15 | 1.89 | 1.40 | 0.16 | 0.15 | 3.72 | 0.33 | 2.72 |
| €/kg P | 1.22 | 0.51 | 2.13 | 0.87 | 0.23 | 0.28 | 3.10 | 0.67 | 2.16 |

| Member State | NL | AT | PL | PT | RO | SI | SK | FI | SE |
|---|---|---|---|---|---|---|---|---|---|
| €/kg N surplus | 5.71 | 0.88 | 0.59 | 0.82 | 0.30 | 0.58 | 0.61 | 0.16 | 0.27 |
| €/kg P | 4.93 | 1.19 | 0.70 | 1.00 | 0.45 | 0.91 | 0.89 | 0.21 | 0.31 |

*Sources: Andersen et al, 2011 and 2019, Hansen et al 2010, Pizzol and Thomsen 2014*

These values for the external costs of a kg per year of excess nitrogen and phosphorus were multiplied by figures from Eurostat[39] for the nitrogen surplus from agriculture in each Member State. In addition, European Environment Agency (EEA) databases were used for industrial emissions as well as for wastewater discharges and the availability and effectiveness of waste water treatment plants, from which the sectoral split between industry and households can be derived. The results for each Member State are shown in Table 5. Overall, for the EU the annual costs are estimated to be over €22 billion per year, comparable to the GDP of Estonia.

[38] For a discussion, see Annex 3.

[39] Eurostat, Agri-environmental indicator - gross nitrogen balance (aei_pr_gnb), https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agri-environmental_indicator_-_gross_nitrogen_balance

## Table 5: Costs of water pollution by Member State (€ million / year)

| | Non-point sources (agriculture) | | | | Point-sources (Households and industry) | | Total |
|---|---|---|---|---|---|---|---|
| | Nitrogen leaching | | Phosphorus leaching | | Waste water | | |
| **Million € per year** | **Drinking water** | **Surface water** | **Surface water** | **Soil; Cadmium** | **Households** | **Industry** | **Total** |
| EU 27 | 6,098 | 7,715 | 3,467 | 70 | 3,934 | 1,059 | 22,343 |
| Austria | 40 | 94 | 59 | 1.2 | 49 | 168 | 412 |
| Belgium | 592 | 214 | 187 | 3.8 | 191 | 30 | 1,218 |
| Bulgaria | 2 | 54 | 13 | 0.3 | 27 | 4 | 101 |
| Croatia | 70 | 42 | 7 | 0.1 | 53 | 0 | 172 |
| Cyprus | 12 | 5 | 4 | 0.1 | 9 | 2 | 32 |
| Czechia | 352 | 97 | 44 | 0.9 | 39 | 30 | 562 |
| Denmark | 82 | 313 | 164 | 3.3 | 50 | 15 | 626 |
| Estonia | 6 | 11 | 2 | 0 | 4 | 1 | 24 |
| Finland | 0 | 21 | 6 | 0.1 | 21 | 88 | 137 |
| France | 1,196 | 1,313 | 380 | 7.7 | 462 | 100 | 3,459 |
| Germany | 2,143 | 1,443 | 971 | 19.6 | 863 | 72 | 5,512 |
| Greece | 38 | 202 | 47 | 0.9 | 50 | 2 | 340 |
| Hungary | 8 | 104 | 45 | 0.9 | 31 | 13 | 203 |
| Ireland | 71 | 224 | 95 | 1.9 | 42 | 1 | 435 |
| Italy | 168 | 1,304 | 485 | 9.8 | 980 | 48 | 2,995 |
| Latvia | 1 | 16 | 4 | 0.1 | 7 | 0 | 28 |
| Lithuania | 0 | 26 | 12 | 0.2 | 11 | 4 | 54 |
| Luxembourg | 30 | 12 | 8 | 0.2 | 9 | 0 | 60 |
| Malta | 1 | 2 | 1 | 0 | 17 | 83 | 104 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Netherlands | 707 | 413 | 297 | 6.0 | 248 | 89 | 1,759 |
| Poland | 148 | 324 | 165 | 3.3 | 129 | 19 | 789 |
| Portugal | 25 | 147 | 48 | 1.0 | 104 | 24 | 350 |
| Romania | 9 | 193 | 53 | 1.1 | 90 | 6 | 351 |
| Slovakia | 17 | 50 | 20 | 0.4 | 44 | 28 | 159 |
| Slovenia | 2 | 15 | 9 | 0.2 | 18 | 5 | 48 |
| Spain | 378 | 1,026 | 328 | 6.6 | 338 | 36 | 2,113 |
| Sweden | 0 | 49 | 12 | 0.2 | 47 | 192 | 301 |

*Data sources: Eurostat; EEA-EPRTR; Danube Commission; EUREAU; Valuation based on Hansen et al. 2009; Andersen et al. 2011; Pizzol et al. 2014 and Andersen et al. 2019.*

## 2.3. The external costs of waste management

The different forms of waste management impose a range of external costs on society whilst also, in some instances, helping to offset external costs elsewhere. Some forms of recycling and recovery, for instance, avoid emissions associated with extracting and processing raw materials, or generating energy elsewhere. This report, however, is only concerned with direct emissions from waste management. It should be noted that some of the emissions to air and water of waste management processes are already captured in the sections on air and water pollution above (meaning that the totals should not be aggregated).

The principal external costs of waste management are as follows:

- **Landfill** sites generate the GHG methane as biodegradeable waste decomposes in anaerobic conditions. Landfill methane is frequently captured and used to generate energy, but capture rates fall well short of 100%. Landfills can also contaminate soil and groundwater as a result of water mixing with the waste to produce leachate. Finally, landfills and other waste management processes such as incineration generally result in a loss of amenity to nearby residents;
- Emissions to air from **incineration** include the flue gas from the incineration process, producing contaminants such as particulates, dioxins, heavy metals and their compounds, acid gases, nitrogen oxides, volatile organic compounds, as well as emission of carbon dioxide. Furthermore, emission of carbon dioxide is influenced by the composition of the waste rather than the treatment process;
- **Composting and mechanical and biological treatment (MBT)** involve externalities from emissions of methane and other GHGs.
- **Combustion of biogas from anaerobic digestion** to produce energy generates emissions of various air pollutants.
- Waste **collection and transportation** involve externalities such as noise, air pollution and emission of GHGs.

Emission factors were sourced from literature for the different waste treatment processes and combined with the values for air pollution and GHGs described in section 2.1 above, as well as estimates for disamenity costs, to give a series of figures for the external cost per tonne of waste treated by each process in each Member State. The results are shown in Table 6.

The externality cost of recycling mainly comes from emissions of PM2.5 and NOx from certain recycling processes. The large variation in damage costs for PM2.5 and NOx (see Table 3) across Member States in turn translates into a large variation in the external costs of recycling. It should be noted that we have not accounted for avoided $CO_2$ or other emissions due to reduced used of virgin materials when recycling takes place. Such effects can clearly take place, but data to analyse them is lacking. For other waste management processes the cost figures in Table 6 are net of avoided emissions from alternative forms of energy generation, where relevant.

**Table 6: External costs of waste management per tonne of waste treated, EU-27 (€/tonne)**

| | Landfill | Incineration (without energy recovery) | Other Disposal Methods | Energy Recovery | Recycling | Waste Transportation |
|---|---|---|---|---|---|---|
| **EU-27** | 316.63 | 193.12 | 0.08 | 112.31 | 131.66 | 3.55 |
| **Austria** | 327.99 | 212.40 | -0.06 | 109.88 | 228.68 | 3.55 |
| **Belgium** | 318.96 | 200.87 | -0.07 | 106.87 | 205.25 | 3.55 |
| **Bulgaria** | 313.01 | 180.22 | 0.24 | 117.33 | 50.30 | 3.55 |
| **Croatia** | 317.12 | 189.87 | 0.15 | 114.15 | 101.76 | 3.55 |
| **Cyprus** | 311.03 | 179.54 | 0.22 | 113.58 | 46.59 | 3.55 |
| **Czechia** | 319.78 | 196.33 | 0.07 | 112.21 | 142.06 | 3.55 |
| **Denmark** | 315.32 | 188.40 | 0.14 | 111.45 | 96.65 | 3.55 |
| **Estonia** | 310.19 | 177.03 | 0.25 | 114.85 | 32.95 | 3.55 |
| **Finland** | 310.44 | 177.01 | 0.25 | 115.11 | 34.79 | 3.55 |
| **France** | 320.49 | 199.70 | 0.03 | 109.22 | 160.18 | 3.55 |
| **Germany** | 325.01 | 209.60 | -0.09 | 107.66 | 228.58 | 3.55 |
| **Greece** | 309.76 | 177.11 | 0.23 | 114.19 | 38.42 | 3.55 |
| **Hungary** | 320.87 | 197.48 | 0.07 | 113.11 | 145.36 | 3.55 |
| **Ireland** | 315.36 | 190.30 | 0.11 | 109.28 | 105.25 | 3.55 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Italy** | 319.51 | 197.92 | 0.03 | 109.93 | 157.04 | 3.55 |
| **Latvia** | 311.24 | 178.37 | 0.24 | 115.64 | 41.02 | 3.55 |
| **Lithuania** | 313.54 | 183.11 | 0.20 | 114.65 | 64.67 | 3.55 |
| **Lux'bourg** | 338.45 | 240.62 | -0.39 | 98.21 | 400.64 | 3.55 |
| **Malta** | 308.67 | 174.00 | 0.27 | 115.54 | 20.72 | 3.55 |
| **Neth'lands** | 318.30 | 202.43 | -0.10 | 102.75 | 205.27 | 3.55 |
| **Poland** | 314.68 | 186.67 | 0.15 | 113.36 | 93.40 | 3.55 |
| **Portugal** | 308.74 | 174.94 | 0.23 | 115.45 | 37.82 | 3.55 |
| **Romania** | 317.23 | 189.62 | 0.15 | 114.80 | 100.26 | 3.55 |
| **Slovakia** | 319.85 | 195.75 | 0.09 | 112.69 | 132.75 | 3.55 |
| **Slovenia** | 318.97 | 193.67 | 0.11 | 113.47 | 123.62 | 3.55 |
| **Spain** | 311.47 | 180.65 | 0.20 | 113.58 | 59.22 | 3.55 |
| **Sweden** | 312.70 | 181.33 | 0.21 | 114.66 | 61.09 | 3.55 |

*Source: own calculation*

Finally, the resulting values for the external cost per tonne of waste managed via each form of treatment were multiplied by the total waste treated using the respective treatment processes in each Member State provided by Eurostat[40]. As with the Eurostat database for air pollution and GHG emissions, this data can be disaggregated by economic sectors according to the NACE Rev. 2 classification. For waste treatment costs, we have disaggregated the results into five economic sectors (energy, industry, households, agriculture and other), including transport in the 'other' category given costs for this sector are in this instance very small. Further detail on the approach to translate NACE Rev. 2 codes into the sectors is given in section 3.1 below.

The resulting figures for the total external cost of waste management per Member State and per sector are given in Table 7, showing that for the majority of Member States the largest share of costs relate to the industry sector.

[40] Eurostat Data Explorer, http://appsso.eurostat.ec.europa.eu/nui/show.do?lang=en&dataset=env_wastrt, Accessed 14 June 2020

## Table 7: Total external cost of waste management by Member State (€m/year)

| | Energy | Industry | Households | Agriculture | Other (including Transport) | Total |
|---|---|---|---|---|---|---|
| **EU-27** | 13,998 | 186,056 | 31,261 | 3,171 | 185,072 | 419,558 |
| **Austria** | 129 | 1,421 | 1,067 | 32 | 12,662 | 15,311 |
| **Belgium** | 125 | 2,357 | 806 | 43 | 6,768 | 10,100 |
| **Bulgaria** | 2,559 | 27,455 | 763 | 166 | 1,435 | 32,378 |
| **Croatia** | 17 | 148 | 157 | 68 | 334 | 724 |
| **Cyprus** | 0 | 134 | 56 | 3 | 157 | 350 |
| **Czechia** | 120 | 650 | 484 | 15 | 2,159 | 3,429 |
| **Denmark** | 71 | 88 | 298 | 17 | 1,322 | 1,796 |
| **Estonia** | 1,112 | 2,774 | 79 | 21 | 452 | 4,437 |
| **Finland** | 299 | 28,088 | 489 | 0 | 4,627 | 33,503 |
| **France** | 273 | 4,612 | 5,496 | 248 | 50,272 | 60,901 |
| **Germany** | 1,726 | 10,712 | 6,343 | 191 | 48,860 | 67,831 |
| **Greece** | 394 | 9,454 | 738 | 39 | 522 | 11,147 |
| **Hungary** | 499 | 549 | 562 | 94 | 1,380 | 3,084 |
| **Ireland** | 21 | 497 | 98 | 7 | 364 | 987 |
| **Italy** | 432 | 4,598 | 4,845 | 52 | 16,457 | 26,384 |
| **Latvia** | 24 | 41 | 72 | 30 | 43 | 210 |
| **Lithuania** | 19 | 406 | 163 | 37 | 344 | 970 |
| **Lux'bourg** | 2 | 206 | 165 | 8 | 2,236 | 2,617 |
| **Malta** | 0 | 9 | 9 | 1 | 83 | 102 |
| **Neth'lands** | 231 | 1,569 | 965 | 574 | 12,586 | 15,925 |
| **Poland** | 2,439 | 11,977 | 1,134 | 64 | 6,026 | 21,638 |
| **Portugal** | 9 | 292 | 485 | 5 | 667 | 1,458 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Romania** | 2,363 | 55,671 | 1,411 | 175 | 1,508 | 61,128 |
| **Slovakia** | 145 | 570 | 286 | 120 | 486 | 1,608 |
| **Slovenia** | 87 | 160 | 70 | 7 | 285 | 610 |
| **Spain** | 646 | 5,760 | 3,614 | 1,045 | 10,424 | 21,489 |
| **Sweden** | 256 | 15,857 | 605 | 110 | 2,612 | 19,440 |

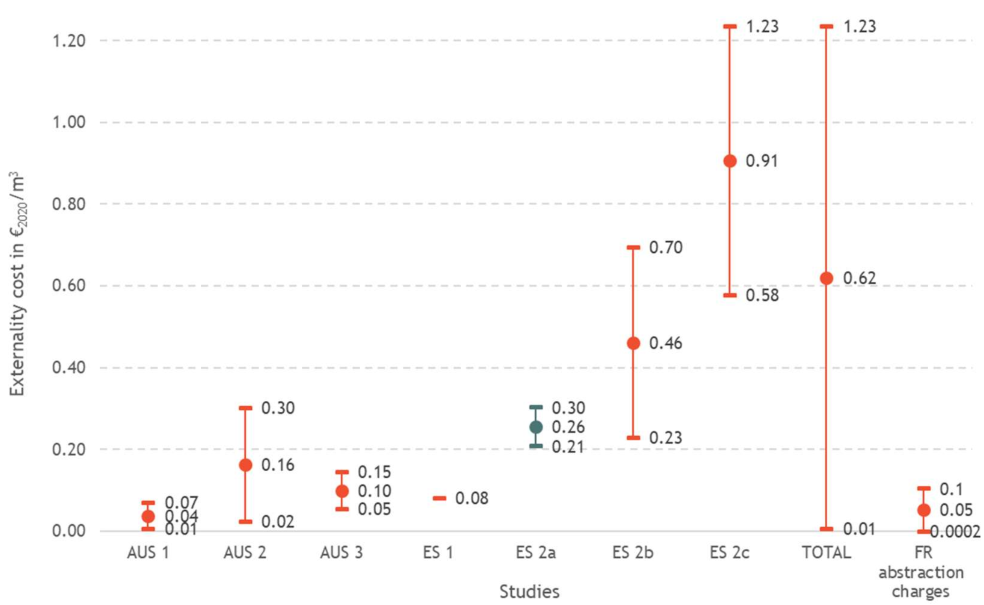
*Source: own calculation*

## 2.4. The costs of water scarcity

The costs of water scarcity are the foregone ecosystem services which water would have provided had it been plentiful. As well as provisioning services to agriculture, industry and households, these include recreational, flood management and nutrient cycling as well as non-use values such as the provision of habitat for species.

The study team found seven academic studies of the costs of water scarcity – three Australian and four from Spain, as described in Annex 4 and represented in Figure 7 below. In summary, externality values converted to Euros in 2019 range from €0.01/m$^3$ to as high as €1.22/m$^3$. The examples from Australia are however considered to be more relevant estimates for the environmental externality on a unit basis than the Spanish examples, which measure surrogates. As such, we suggest an externality value with a maximum of €0.30/m$^3$ (the maximum externality value identified in the Australian literature). This could be used as a guide for Member States when considering MBIs to address over-extraction in their river basin areas. They could be applied to all units of water extracted from the resource, in an externality charge, for example.

*Figure 7: Examples of estimated costs of water scarcity*



It is not possible with the limited data available to provide an estimate for the total external costs of water scarcity across the EU. Instead, the study examined five case studies selected as being illustrative of different types of water scarcity scenario, comparing the actual use (if any) of charges with the theoretical level suggested by the literature review. As discussed in section 3.4 below, using the externality value of €0.30/m$^3$ we found total costs in these five case studies alone to amount to some €3.5-4.4 billion per year.

It should be noted that external costs will vary from one catchment to another, and therefore further study at catchment level would be needed to determine appropriate values for specific locations. However, even though it is derived from Australian studies of severe water stress, the figure of €0.30/m$^3$ is regarded as conservative, since the studies only examined a subset of costs.

## 2.5. The external costs of harm to biodiversity

Biodiversity is harmed by air and water pollution, water scarcity and pollution associated with waste. Those impacts are counted where possible in previous sections of this report. As with water scarcity, this study has looked at biodiversity in terms of the valuable ecosystem services it can provide and which are diminished if biodiversity is harmed. There is an enormous range of results from valuation studies of these services. The study focussed on one aspect of biodiversity – forests – in the expectation of finding a degree of congruence between the available valuation studies. However, a meta review[41] found a range of values from other studies from €0.07 to over €2 million per hectare. The range of values for the ecosystem services of forests in studies found by the study team is shown in Table 8 below.

**Table 8: Estimated values for a hectare of forest from literature reviewed for this study**

| Ecosystem type | Country/ region | Valuation method | Service(s) valued | Value/ha/year | Source |
|---|---|---|---|---|---|
| **Meta analyses** | | | | | |
| European forests | Europe | Various | Recreational values | €0.07 - €2,033,370 | (Nieto Quintano & Barredo, 2015) |
| **Individual studies** | | | | | |
| Riparian forest (chick-weed-oak-hornbeam forest) | Germany | Avoided cost | Water conservation and flood protection | €1,900 - €4,300 | (Barth & Doell, 2016) |

[41] P. Nieto Quintano and J. Barredo Cano (2015) A database of the recreational value of European forests, https://publications.jrc.ec.europa.eu/repository/handle/JRC95103

| | | | | | |
|---|---|---|---|---|---|
| Riparian forests | Latvia | Benefit transfer method | Multiple | €2,800 | (Saklaurs, et al., 2016) |
| Forests | European Mediterranean region | Various | Multiple | €173 | (Croitoru, 2007) |
| Different forest types | North Zealand, Denmark | Combination of discrete choice model, count data model and GIS | Recreational values | €200 - €14,850 | (Zandersen & Termansen, 2013) |

*Source: own compilation*

With such a wide range of valuations it is clear that site specific factors strongly influence the valuation of ecosystem services from forestry. The range makes it impossible to propose a single figure for the external cost per hectare of forestry as was done for water scarcity. And without a reliable figure for external cost per hectare, it was considered impossible to estimate the total cost to forestry of economic activity.

## 2.6. Estimated total costs of air and water pollution, greenhouse gases, waste treatment, water scarcity and biodiversity loss

It is clear that the cost estimates presented in these five areas of environmental damage are partial. As noted in the methodological limitations section 1.1 above, it was not possible to consider a variety of additional environmental costs, and alternative methods (for example to derive the costs of GHGs) may have resulted in far higher estimates than those presented here.

Nonetheless, it is clear even from these partial estimates that the external environmental costs of pollution in the EU are substantive. The combined costs of air pollution, GHGs and water pollution alone amounts to at least €750bn/year – in excess of the annual national GDP of 23 EU Member States[42] or equivalent to the combined annual GDP of Finland and Sweden – while in just five case study regions, the costs of water scarcity were found to amount to €3.5-4.4 billion per year.

If, in addition to the costs of air pollution, GHGs and water pollution, we were to consider such water scarcity costs across the EU, in addition to the disamenity costs of waste management, and the potentially very high costs of biodiversity loss, it is not unreasonable to assume total costs of environmental damage across the five areas of study would be well in excess of €1 trillion per year.

[42] All of the EU27 Member States except for Germany, Spain, France and Italy.

# 3. Is the polluter paying for these costs?

## 3.1. Environmental tax and other economic instrument revenues

In this research, revenues from environmental taxes and other economic instruments have been used to derive an estimate of the extent to which the polluter pays for the damage assessed in section 2 above, according to the formula provided in section 1.1.2.

The main data sources used to identify the revenues from environmental taxes and MBIs include the Eurostat National Tax List[43] and the OECD PINES database[44]. Supplementary information was provided by the study team's Member State (MS) experts, who helped to verify and supplement the data available from Eurostat and the OECD. This provided an overview of all taxes and charges, fees and levies, and Extended Producer Responsibility payments at the level of Member States for which the tax base is a physical unit of something that has a proven, specific and negative impact on the environment[45].

This includes, for example, vehicle taxes and fuel excise duties, even if revenues from such sources may be earmarked in some instances for other purposes such as road infrastructure investment. In the case of water charges, however, based on the Water Framework Directive's recommendation that water pricing policies should reflect environmental and resource costs in addition to the cost-recovery principle for the provision of water services, an effort has been made to identify only the revenues from taxes levied to provide incentives for reducing environmental externalities.

Economic instruments whose revenues are not collected by national governments were excluded (with a particular affect, for example, on instruments to address waste, many of which generate revenues only at the municipal level). VAT is not included in the analysis, since it is deductible for many producers, although not for households, and therefore does not influence price-setting in the same way as taxes on environmental tax bases[46].

The MS experts in the study team categorised each Member State's revenues according to the five themes for which cost estimates have been made: air pollution and GHG emissions, water pollution, water scarcity, biodiversity and waste. In general, taxes on air pollutants, energy taxes and transport taxes are considered to be related to air pollution and GHG emissions; fees based on emissions to water or for cleaning water to water quality; and resource taxes to waste. In some instances it was not possible to identify any revenues for certain Member States and certain themes, due to a lack of data availability (for example, waste management revenues in Cyprus, Denmark, Croatia and Luxembourg).

Table 10 shows the resulting revenues by Member State and theme, totalling over €355bn in 2017. This is around 15% higher than identified by Eurostat, largely due to identifying additional tax revenues from measures which tackle waste and biodiversity. It amounts to well under half of the total costs identified – noting the partial and conservative nature of the

[43] Eurostat, Tax revenue statistics, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tax_revenue_statistics

[44] OECD, Database on Policy Instruments for the Environment PINE database portal, https://pinedatabase.oecd.org/

[45] Eurostat, Environmental taxes, https://ec.europa.eu/eurostat/web/environment/taxes

[46] Eurostat (2013) Environmental taxes – A statistical guide, https://ec.europa.eu/eurostat/documents/3859598/5936129/KS-GQ-13-005-EN.PDF. See also section 3.4 of Eurostat (2020) Metadata for Environmental tax revenues (env_ac_tax), https://ec.europa.eu/eurostat/cache/metadata/EN/env_ac_tax_esms.htm

estimates as described above – across the five different forms of pollution and environmental damage assessed in this study.

The vast majority of revenues, almost 90%, are assessed to relate to measures to address air pollution and GHGs. These revenues were further disaggregated according to the six economic sectors used in this study – agriculture, energy, households, transport and other – based on the NACE Rev. 2 statistical classification available in the Eurostat database[47] (and aligned with the same classification in the Eurostat databases for air pollution and GHGs and for waste treatment, as described in sections 2.1 and 2.3.) The translation from the NACE Rev. 2 classification to these six simplified sectors (or five in the case of waste) is described in Table 9 below.

It is important to note, that in this study the transport sector is therefore defined according to the NACE sector H (Transportation and storage), which means that emissions caused by using personal transport vehicles, and taxes based on motor fuels paid by households, for example, are allocated to the household sector and not to the transport sector.

**Table 9: Translation table NACE Rev. 2 to sectors used in this study**

| NACE Rev 2. categories | Sector in this study |
|---|---|
| A - Agriculture, forestry and fishing | Agriculture |
| B - Mining and quarrying | Industry |
| C - Manufacturing | Industry |
| D - Electricity, gas, steam and air conditioning supply | Energy |
| E - Water supply; sewerage, waste management and remediation activities | Other |
| F - Construction | Other |
| G - Wholesale and retail trade; repair of motor vehicles and motorcycles | Other |
| H - Transportation and storage | Transport |
| I-U - Services (except wholesale and retail trade, transportation and storage) | Other |
| EP_HH - Households | Households |
| EP_NRES - Non-residents | Households |
| NAL - Not allocated | Other |

[47] Eurostat (2008) NACE Rev. 2 - Statistical classification of economic activities in the European Community, https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

**Table 10: Environmental instrument revenue per theme (€ million, 2017)**

| Member State | Total environmental revenues | Air pollution and greenhouse gas revenues | Waste revenues | Water quality revenues | Water stress revenues | Biodiversity revenues | For information – environmental tax revenue according to Eurostat in 2017 | For information – total energy and transport tax according to Eurostat in 2017 |
|---|---|---|---|---|---|---|---|---|
| EU-27 | 355,440 | 317,160 | 3,415 | 890 | 3,000 | 5,280 | 309,440 | 298,990 |
| Austria | 13,450 | 10,790 | 124 | - | 670 | - | 8,840 | 8,760 |
| Belgium | 9,930 | 9,290 | 526 | 120 | - | 120 | 9,770 | 9,230 |
| Bulgaria | 1,470 | 1,350 | 66 | 10 | - | 50 | 1,380 | 1,350 |
| Croatia | 1,790 | 1,690 | 1 | 10 | 100 | - | 280 | 270 |
| Cyprus | 560 | 560 | - | - | - | - | 560 | 560 |
| Czechia | 4,540 | 4,020 | 257 | 10 | 30 | 10 | 4,030 | 4,020 |
| Denmark | 10,500 | 10,260 | - | 40 | 210 | 40 | 10,300 | 8,950 |
| Estonia | 830 | 690 | 95 | - | 40 | - | 680 | 610 |
| Finland | 6,690 | 6,640 | 28 | - | - | - | 6,690 | 6,630 |
| France | 61,830 | 52,680 | 81 | 140 | 300 | 1,790 | 52,930 | 49,810 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Germany | 72,100 | 63,670 | - | 300 | - | - | 59,260 | 59,250 |
| Greece | 7,180 | 7,160 | - | - | - | - | 7,160 | 7,160 |
| Hungary | 3,310 | 2,610 | 308 | 10 | 360 | - | 2,910 | 2,600 |
| Ireland | 5,150 | 5,100 | 32 | - | - | - | 5,150 | 5,100 |
| Italy | 69,970 | 60,550 | 541 | - | - | - | 57,380 | 56,700 |
| Latvia | 670 | 650 | 26 | - | - | - | 640 | 620 |
| Lithuania | 830 | 780 | 8 | 30 | 10 | - | 810 | 770 |
| Luxembourg | 950 | 940 | - | - | 10 | - | 950 | 940 |
| Malta | 390 | 270 | 22 | - | 90 | - | 300 | 270 |
| Netherlands | 24,750 | 21,230 | 378 | 20 | 300 | 2,850 | 24,560 | 21,230 |
| Poland | 12,390 | 12,210 | 47 | 110 | - | 110 | 12,290 | 11,730 |
| Portugal | 5,160 | 4,970 | 136 | 10 | 40 | 10 | 5,040 | 4,960 |
| Romania | 3,450 | 3,450 | 4 | - | - | - | 3,450 | 3,440 |
| Slovakia | 1,530 | 1,490 | 2 | 20 | 40 | 10 | 1,500 | 1,480 |
| Slovenia | 1,600 | 1,540 | 7 | 20 | 30 | 20 | 1,600 | 1,540 |
| Spain | 24,890 | 23,200 | 689 | 40 | 790 | 180 | 21,380 | 20,440 |

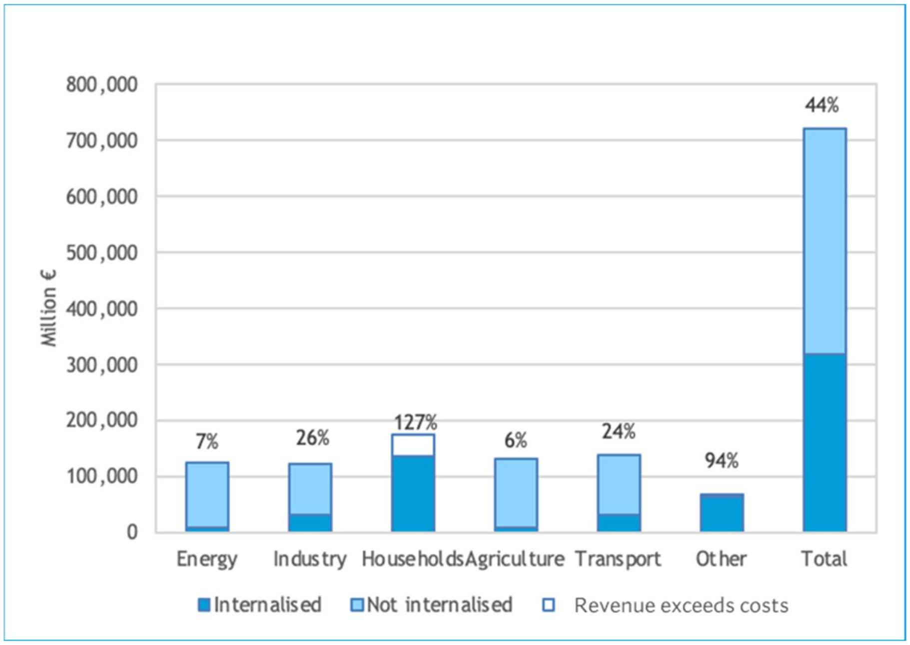
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sweden | 9,520 | 9,390 | 37 | - | - | 100 | 9,240 | 9,070 |

*Source: Eurostat National Tax List, OECD PINES database and information from MS. Compilation by the authors.*
*Note: The total estimate of revenues is around 15% higher than identified by Eurostat in 2017. For a large part this comes from identifying additional revenues from measures which tackle waste and biodiversity.*

## 3.2. Internalisation rates of costs of air pollution and GHGs

A comparison of the costs of air pollution and GHGs (shown in aggregate in Table 3) with tax revenues related to air pollution and GHGs (shown in aggregate in Table 10) leads to estimated values for the extent to which the cost of air pollution and GHGs is internalised in taxation in the EU. Results at EU level, in total and disaggregated by the six economic sectors used in this study (see section 3.1 above) are shown in Figure 8 and results for each Member State in Annex 2.

*Figure 8: Extent to which air pollution and GHG costs are internalised in the EU, 2017*




*Source: own calculations*

*Note: The total for households includes revenues which include both taxes and user charges; the proportion of each cannot be estimated.*

Overall the total cost assessed for air pollution and GHGs of over €720 billion in the EU is equal to around 5% of EU GDP and represents a large annual reduction in the quality of life of EU citizens. Figure 8 shows that overall, only 44% of these costs of air pollution and GHGs are reflected in taxation, charges or other economic instruments, leaving external costs in excess of 3% of EU GDP that are not internalised.

As discussed above, this may be seen to represent an over-estimate of the rate of internalisation, given that not all of the costs may be adequately captured in our estimate and given that a large share of the assessed revenues derive from taxes or charges which may be considered to relate to a wider range of external costs beyond environmental damage alone, especially in the household sector.

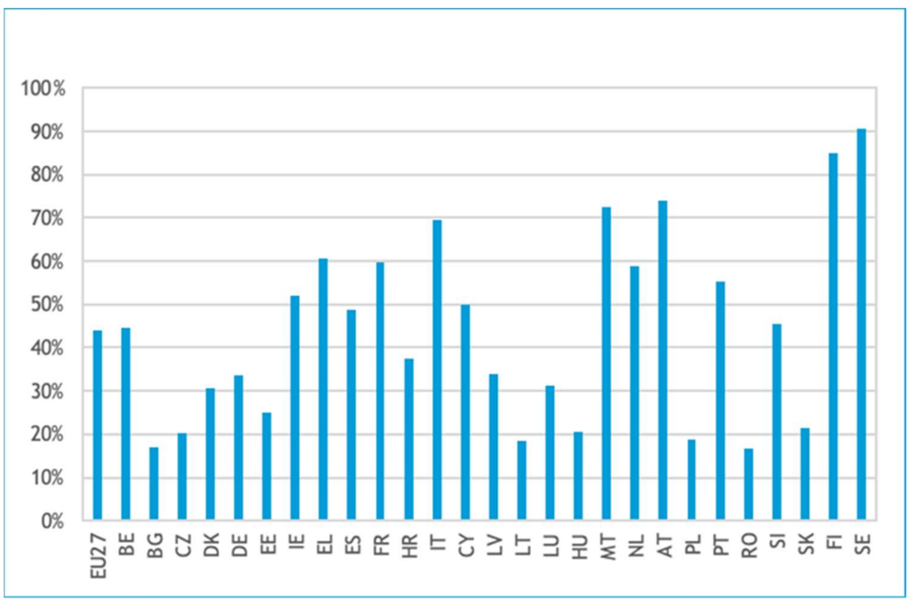
As Figure 8 shows, there is a wide variation in the internalisation rates among the assessed economic sectors, with the household sector found to have the highest degree of internalisation of its costs of air pollution and GHGs. It is worth noting, however, that a substantial part of the payments contributed by households are for transportation and motor fuel taxes (which are not allocated in this study to the transport sector, as described in section 3.1 above), the revenues from which are not only meant to reflect air pollution damage but may also be used to cover government expenditure to build and maintain infrastructure, for example.

It is nonetheless significant that households internalise substantially more of their environmental costs than the energy, industry or agriculture sectors, for example. Indeed, the agriculture sector – which contributes a similar level of costs in absolute terms to these other sectors, primarily as a result of $NH_3$ emissions – has a particularly low internalisation rate, at just 6% of its air pollution and GHG emission costs.

The extent to which air pollution and GHG costs are internalised also varies considerably between Member States. The total figures across all sectors per Member State shown in Figure 9, range from 17% in Bulgaria and Romania to 91% in Sweden, but with 16 of 27 Member States having internalisation rates below 50%.

Behind these total economy-wide figures, there is also substantial variation in the internalisation rates in different sectors across the Member States (see Annex 2). For example, the internalisation rate for industry varies between 5% for Slovakia to 72% for Malta; and for households between 10% for Bulgaria to over 300% for countries like Denmark, Finland and Sweden. For the energy sector, 24 out of 27 Member States internalise less than a third of the costs; while for the agriculture sector 24 Member States have internalisation rates below 15%, and the EU's three largest agricultural producers (Germany, France and the Netherlands) internalise just 5%, 6% and 7% of their air pollution and GHG costs respectively.

*Figure 9: Taxes as a proportion of the costs of air pollution and GHG by Member State*



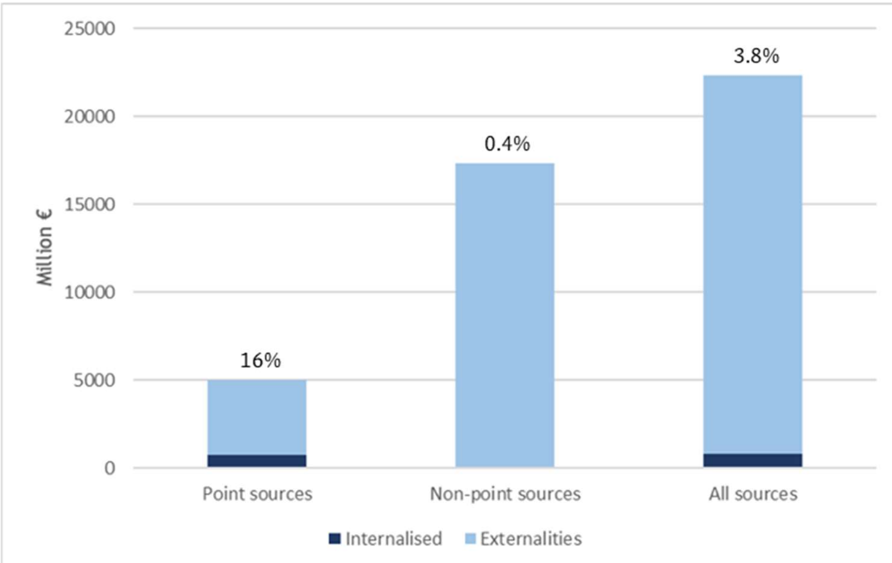

*Source: own analysis*

## 3.3. Internalisation rates of costs of water pollution

Comparison of the costs of water pollution, shown in Table 5 with the tax revenue associated with activities which pollute water, shown in Table 10, shows that water pollution is much less heavily taxed than air pollution and GHGs. Overall, just 3.8% of the water pollution costs estimated in this study are covered by taxes, charges or other market instruments, although there is a notable difference between point and non-point sources, as shown in Figure 10.

While 16% of the estimated externalities from point sources are taxed, the share with respect to non-point sources is negligible (0.4%).

*Figure 10: Extent to which water pollution costs are internalised, EU-27, 2017*



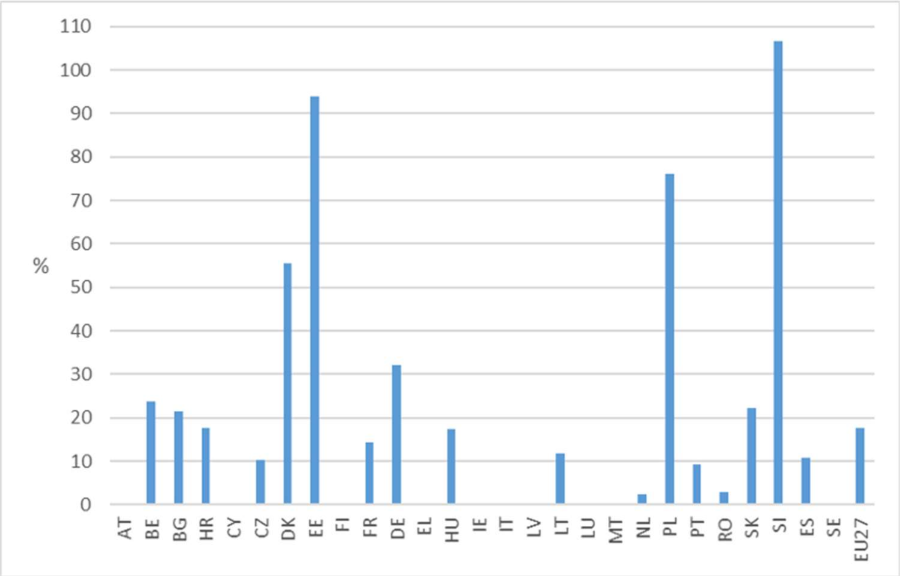

*Source: own calculations using Eurostat, EEA and OECD data*

As noted above, in the case of water pollution, these revenue figures exclude charges for water and sewerage services on the basis of information provided by the water authorities in the Member States concerned, and focus on taxes and charges explicitly addressing water pollution externalities (although service charges can, if properly designed, allow for cost recovery and also provide incentives to reduce emissions.) However, since external cost values were derived for some rather than all water pollutants, the calculations are still likely to overstate the extent to which polluters are paying.

Similar to the case with taxes related to air pollution and GHGs, there is wide variation in the water pollution internalisation rates among Member States, as shown in Figure 11 with regard to point sources of water pollution. There are apparently high levels of internalisation in a number of central and eastern European Member States (Estonia, Poland, Slovenia), due to the legacy of water pollution taxes in place for many decades, although based on the assumption that all urban water treatment plants comply with the limits in the Urban Waste Water Treatment Directive. Other central and eastern European Member States with taxes in place record lower revenues (Czechia, Slovakia, Hungary, Romania). Among the western Member States, Denmark, Germany and Belgium record the highest revenues from taxation of waste water.

With regard to water pollution from non-point sources, the highest tax burden is found in France where there is a tax on livestock manure, however it corresponds to just 2% of the estimated externalities. Netherlands, Belgium, Denmark and Croatia also have small amounts of revenue from various types of manure and fertilizer taxes.

*Figure 11: Point sources (all sectors): share of water pollution externalities subject to taxation*




*Source: own calculations*

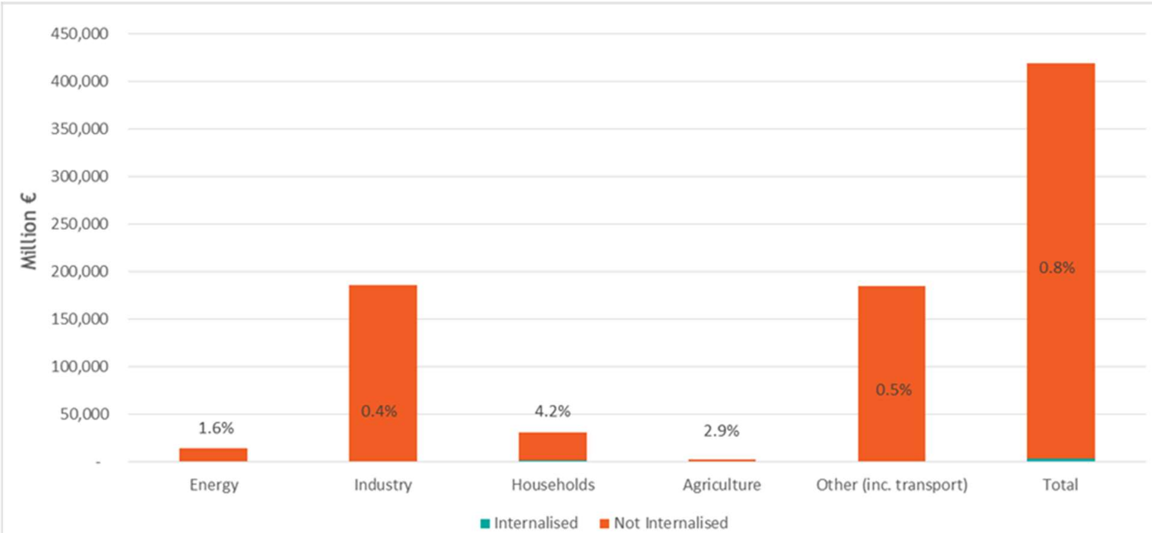
## 3.4. Internalisation rate of the costs of waste management

A comparison of the external costs of waste management per Member State and per economic sector from Table 7 with the total revenues generated via Member State-level economic instruments (shown at the aggregate Member State level in Table 10), reveals that just 0.8% of the total costs are internalised, as shown in Figure 12 below.

It is notable that the industry sector, despite making the biggest contribution to the external costs among the sectors assessed in this study, has the lowest internalisation rate of all at just 0.4%. Similar to the finding with regard to the costs of air pollution and GHGs, households have the highest internalisation rate, albeit still covering less than 5% of the costs of waste management. We also identified variation among Member States, with internalisation rates ranging from just 0.01% in Romania to just over 20% in Malta, although 17 Member States were found have a rate below 5%, and 11 of which to have a rate below 1%.

It is however important to note that these results should be treated with a degree of caution given the data gaps in identifying revenues in several Member States, and given that a substantial share of revenues from economic instruments related to the waste sector are collected at municipal level or by other actors including in the private sector, and are therefore excluded from this analysis.

*Figure 12: Internalisation of external costs of waste management (€m) across EU*




## 3.5. Internalisation rates of the costs of water scarcity

As described in section 2.4 above, the impacts of water scarcity on ecosystem services are location specific and further work at river basin level would be required to understand them properly. Nevertheless, an external cost of €0.3/m$^3$ derived from Australian studies can be taken as a conservative proxy for likely external costs across Europe.

The five case studies assessed in this study (see Annex 5) demonstrate that existing charges for water abstraction – where they exist at all – fall a long way short of internalising these estimated costs. As shown in Table 11 below, we find an internalisation rate across the five case studies of 2-3%. The case studies themselves can be found in Annex 5.

**Table 11: Results of case studies comparing the assumed cost of water abstraction externalities with the charges raised**

| Case study | Revenue from charges | Revenue achievable through an externality charge of €0.3/m$^3$ | Approximate internalisation rate |
|---|---|---|---|
| Thessalia, Greece | • Agriculture, forestry and fishing: €1.4 - 1.9 million<br>• Households: €0.003 - 0.004 million | • Agriculture, forestry, and fishing: €177 - 238 million<br>• Households: €0.5 - 0.7 million | • Agriculture, forestry and fishing: 0.6 - 1.1%<br>• Households: 0.4 - 0,8% |
| Mid- Apennine region, Italy | €0 | • Agriculture, forestry, and fishing: €348 - 539 million<br>• Electricity, gas, steam and air conditioning | 0% |

| | | | |
|---|---|---|---|
| | | supply: €226 - 266 million<br>• Mining and quarrying, manufacturing and construction: €79 - 102 million<br>• Service industries: €2 million<br>• Water collection, treatment and supply: €201 - 211 million<br>• Households: €4 million | |
| Black Sea Basin district, Bulgaria | • Agriculture, forestry, and fishing: €0.07 - 0.13 million<br>• Households: €0.007 - 0.008 million | • Agriculture, forestry, and fishing: €15 - 30 million<br>• Households: €0.04 million | • Agriculture, forestry and fishing: 0.2 - 0.9%<br>• Households: 17.5 - 20% |
| Jucar Region RBD, Spain | €0 | • Agriculture, forestry, and fishing: €985 - 1,158 million<br>• Electricity, gas, steam and air conditioning supply: €28 - 33 million<br>• Mining and quarrying, manufacturing and construction: €5 - 6 million<br>• Service industries: €121 – 125 million<br>• Water collection, treatment and supply: €201 - 211 million<br>• Households: €2 million | 0% |
| Weser River Basin District, Germany | • Agriculture, forestry, and fishing: €0.5 - 0.7 million<br>• Electricity, gas, steam and air conditioning supply: €29 - 38 million<br>• Mining and quarrying, manufacturing and construction: €33 - 40 million<br>• Service industries: €0.5 million<br>• Water collection, treatment and supply: €26 - 31 million<br>• Households: €0.1 million | • Agriculture, forestry, and fishing: €21 - 31 million<br>• Electricity, gas, steam and air conditioning supply: €745 - 1,000 million<br>• Mining and quarrying, manufacturing and construction: €281 - 343 million<br>• Service industries: €4 million<br>• Water collection, treatment and supply: €132 - 159 million<br>• Households: €0.5-0.6 million | • Agriculture, forestry, and fishing: 1.6 - 3.3%<br>• Electricity, gas, steam and air conditioning supply: 2.9 - 5.1%<br>• Mining and quarrying, manufacturing and construction: 9.6 - 14.2%<br>• Service industries: 12.5%<br>• Water collection, treatment and supply: 16.4 - 23.5%<br>• Households: 16.7 - 20% |
| Total | €91 - 112 million | €3,578 - 4,465 million | 2% - 3% |

*Source: own calculations using EEA WISE data for abstraction rates and actual water charges*

## 3.6. Internalisation rate of the costs of harm to biodiversity

As noted in section 2.5 above, the range of site-specific estimates of the economic value of forests makes it impossible to propose a single figure for the external cost per hectare of forestry, and without a reliable figure for external cost per hectare, the total cost to forestry of economic activity cannot be calculated and compared with any taxes and charges which may exist. Instead of comparing rates of internalisation, therefore, the study collected information on forest taxes and charges for those Member States which levy them at national level, and these are presented in Table 12.

The existing forest fees and charges in Europe vary both in design and rate. In Lithuania, Croatia, Czech Republic and Bosnia and Herzegovina, for example, forest charges are imposed on the income from wood, and different rates often apply to private and public forestry companies, respectively. In Poland and Hungary, the existing fees are based on the amount felled and the type of tree. Arguably, from an internalisation point of view, this design ought to be more appropriate than one based solely on the income from selling wood, as it is more clearly linked to the actual impact on the forest.

It is notable that our rough estimates of the payments per hectare for those Member States where an estimate was possible - in Lithuania, Croatia and Hungary – are significantly lower, at less than €30/ha, than the potentially very high valuations identified in section 2.5, which tend to be measured in the hundreds, if not thousands of Euros per hectare. Despite the high methodological challenges and limitations in this area, these findings suggest that existing fees and charges in the EU are significantly lower than the estimated monetary values per hectare of ecosystem services provided by forests, and that substantially higher fees than those identified would be needed to achieve any meaningful rate of internalisation.

**Table 12: Forest fees and charges in six Member States**

| Member State | Type of measure | Who pays? | Rate | Annual revenue (€) | Fellings of commercial wood ($m^3$/ha; 2010)* | Estimated payment per ha (assuming average price of €60/$m^3$)** |
|---|---|---|---|---|---|---|
| **Lithuania** | Forest charge | Public and private forest holders | 5% of income of sales of raw and standing timber | Unknown | 4.6 $m^3$/ha | €13.8/ ha |
| | Forest charge | Public forest holders | 10% of income of sales of raw and standing timber (in addition to the 5%) | Unknown | | €27.6/ ha |
| **Croatia** | Forest Public Benefit Fee | Public and private forest holders | 0.0265% of total income | €24.9 million (2014) | 3.0 $m^3$/ha | €4.8/ ha |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Bosnia and Herzegovina** | Forest charge | Public forest companies | 3% of income from sales of wood and other forest products | Unknown | Unknown | Unknown |
| | Forest charge | Private forest companies | 15% of income from sales of wood and other forest products | Unknown | | Unknown |
| **Poland** | Charge for tree removal | Unknown | €120/cm of trunk circumference, 130 cm above ground (depending on tree species) | Unknown | 4.8 $m^3$/ha | Unknown |
| | Charge for premature harvesting | Entity causing premature harvesting of forests | Difference between market value of timber from forest reaching cutting age and the one in question | €209 million (2014) | | Unknown |
| **Hungary** | Forest protection charge | Taking registered forestry areas out of cultivation | €1.59-5.16 per gross $m^3$ (depending on tree species and region). Baseline charge of 100,000 HUF/ha) | €0.90 million (2012) | 4.0 $m^3$/ha | €13.6/ ha (based on average fee rate per $m^3$) |
| **Czech Republic** | Fee for withdrawal of forest land | Permanent withdrawal of forests in protected areas, in urban surroundings or with intensive environmental functions | (2 to 5 * yearly wood production [in $m^3$] * price per $m^3$)/0.02 | €2.7 million (2019) | 7.7 $m^3$/ha | Unknown |
| | Fee for withdrawal of forest land | Permanent withdrawal of forests from economic forestry areas | (1.4 * yearly wood production [in $m^3$] * price per $m^3$)/0.02 | | | Unknown |

*Source: literature review by study team*

** Source: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do*
*** Source: Assumed estimate based on average price of different tree species across the year of 2018, from http://www.unece.org/forests/output/prices.html*

## 3.7. Overall conclusions on the extent to which external costs have been internalised in taxation in the EU

Comparing estimates of the external costs of air and water pollution, GHGs, water abstraction, waste management and the management of biodiversity with the environmental taxes and other forms of pricing to which polluters are subjected shows clearly that EU polluters are not being made to pay in full. Of the total (and partial) cost estimates provided here of at least €750bn per year, well under half is internalised in some form of economic instrument.

However the most relevant findings are at the thematic, sectoral and Member State levels. Internalisation rates are highest overall with regard to the costs of air pollution and GHGs, but even here they reach only 44% economy-wide across the EU, and with wide variation between Member States and between economic sectors. It is notable that households in most Member States contribute substantially more in revenues in relation to their air pollution and GHG costs than do sectors like industry, energy or agriculture.

In other areas, internalisation rates across the EU are even lower. The internalisation rate of water pollution costs reaches 16% for point sources, linked to households and industry, but is negligible for non-point sources associated with the agriculture sector, which is by far the major source of pollution.

For the external costs of waste management, the internalisation rate is less than 1% across the EU, and less than 5% in most Member States (although it is notable that these figures exclude significant revenues related to waste that are collected by actors other than national governments). Similar to the case with air pollution and GHG emissions, households face the highest internalisation rate for waste management EU-wide, despite the biggest contribution to external costs relating, by far, to the industry sector.

Estimates for water scarcity and biodiversity are harder to derive, but our case study approaches suggest that in these sectors the internalisation rates are also extremely low. For water scarcity, we found internalisation rates of just 2-3% across our case studies, representing some €3-4 billion of external costs that are unpriced in the five case study regions alone. Similarly, the assessed existing forest charges in Europe are significantly lower than the value of ecosystem services from forests identified in the literature (albeit these are highly site-specific).

Although there are some variations, this picture of failure to make polluters pay is clear across Member States, pollutants and sectors. The next section of this report therefore considers a range of taxes and other market-based instruments through which this might be addressed.

# 4. Using taxes and other market-based instruments to make polluters pay

The analysis in the previous section demonstrates that polluters of air and water are insufficiently taxed, users of scarce water resources are not paying for the damage they cause, and both waste producers and foresters impose external environmental costs for which society is almost certainly not fully compensated. This section reviews a range of taxes and other instruments through which this could be put right. Most of the instruments are already in use somewhere in the EU, although a small number are proposals by the study team which would require further development.

While the fall range of economic instruments considered in the study are described in Box 1, here we simplify by categorising the assessed instruments into two main groups:

- **Taxes** (which may in some cases be referred to as charges, fees or levies) whose main justification is to reflect the cost of pollution, raising revenue and providing an incentive for its reduction;
- **Trading schemes** which use a price signal to ration the use of an environmental asset which is under constraint. An example is tradeable permits for phosphate emissions for livestock farmers in the Netherlands, which ration the use of a limited quantity of emissions set by the Nitrates Directive.

This report considers instruments of both types to tackle the externalities (air and water pollution, water scarcity, waste and harmful management of biodiversity) discussed in section 2. Given economic instruments to address GHGs have been widely discussed elsewhere, they are not further assessed in this study. The instruments considered were identified from a review by the study team of available measures both inside and outside the EU and are listed in Table 13.

For each of these measures, principal design features and – where applicable – a real world example are presented below. Further real world examples from all Member States, including information concerning how the instrument was introduced, is available in the Polluter Pays toolkit accompanying this study.

**Table 13: Economic instruments considered in this report**

| Externality | Instrument | Type |
|---|---|---|
| Air pollution (NOx, PM2.5, $NH_3$) | NOx tax | Tax |
| | Tax on domestic biomass burning | Tax |
| | Tradeable livestock rights for NH3 emissions | Trading scheme |
| Water pollution (N, P, BOD) | Pesticides tax | Tax |
| | Nitrogen fertiliser levy | Tax |
| | Waste water charge | Tax |
| Water scarcity | Externality pricing | Tax |

| | | |
|---|---|---|
| | Cap and trade | Trading scheme |
| Waste | Landfill and incineration tax | Tax |
| | Pay as you throw | Tax |
| | Beverage container tax | Tax |
| Biodiversity | Market-based offsetting | Trading scheme |
| | Forest felling charge | Tax |
| | Intensive livestock charge | Tax |
| | Peat tax | Tax |

*Source: own analysis; taxes can sometimes be referred to as charges*

## 4.1. Environmental taxes

**Table 14: NOx taxes**

| Name of instrument | NOx tax |
|---|---|
| What does the tax or charge apply to? | NOx emissions per tonne from combustion plant > 50 MWh. These are regulated under the IED and recorded in the E-PRTR |
| How should rates be calculated? | Full internalisation is achieved by taxing at the rates per tonne shown in Table 2, which vary by Member State. A Dutch study has shown that higher rates would be needed to reduce emissions to zero. |
| Are any supporting policies required? | Actual emissions must be monitored. This is required for installations > 50 MWh by the IED and E-PRTR. |
| Is there a risk of perverse incentives? | No |
| Real world example | There are many examples of NOx tax implementation, going well back in time. Sweden has had a NOx tax since 1992, which was introduced as part of a general tax reform which moved tax burden from income taxes to environmental bads. It applies to installations generating more than 25 MWh/year (the threshold for inclusion in the ETS). The rate per tonne is set at 50 SEK (approximately €5) compared to the externality cost of €6.9/tonne. The rate is set at a level expected to reduce emissions by 30% as operators with abatement opportunities costing less than €5/tonne make changes. There are exemptions for industries thought to face particularly high abatement costs. Revenue (€56 million in 2017) is recycled to those who pay the tax pro rata to their output (thereby favouring investment in more emissions-efficient technology). |

| | |
|---|---|
| Applicability within the EU | High. NOx emissions from energy generation and industry are at least 25% of total NOx emissions in over half of Member States. |

*Source: own analysis*

Sweden's NOx tax is not a pure externality tax, which would require all emitters to be taxed at the marginal social cost of a unit of emission regardless of the abatement opportunities available to them. It is instead an example of a pragmatic way of achieving a desired reduction of total emissions in an economically efficient way.

### Table 15: A tax on domestic biomass and coal burning

| Name of instrument | Tax on domestic biomass and coal burning |
|---|---|
| What does the tax or charge apply to? | All solid fuels sold for residential use. The tax is levied at the point of sale. |
| How should rates be calculated? | Domestic fuels have differing calorific content and PM emissions per tonne so different rates are needed for different fuels in order to avoid environmentally damaging substitution between fuels. The study team calculated tax rates for wood pellets, other wood, coal and brown coal/lignite based on these factors. This resulted in emission factors for each fuel of:<br><br>Pellets – 45g/GJ<br><br>Other wood – 248.75g/GJ<br><br>Coal – 319.80 g/GJ<br><br>Brown coal/lignite – 344.75 g/GJ<br><br>Applying these factors to the average calorific content of each type of fuel yields average PM2.5 emissions per tonne of that fuel. Multiplying these by the figure for each Member State given in Table 3 for the external cost per tonne of PM2.5 emissions gives an appropriate tax rate in each Member State for each fuel. |
| Are any supporting policies required? | As domestic heating is an essential need, taxing it is potentially a regressive move. This can be alleviated by recycling the revenue as subsidies towards the purchase of more efficient heating. These subsidies can be focussed on poorer households if desired. |
| Is there a risk of perverse incentives? | Yes, if higher prices cause householders to cut wood or lignite themselves rather than pay the tax. |
| Real world example | None |
| Applicability within the EU | High. The residential, commercial and institutional sector is the biggest source of PM2.5 emissions in the EU. |

*Source: own analysis*

Domestic biomass burning is a good example of how lack of understanding of the very high cost of air pollution – and of PM2.5 in particular – has resulted in a serious source of pollution remaining untaxed as a result of the obvious political difficulties associated with increasing the cost of household heating.

### Table 16: Pesticides tax

| Name of instrument | Pesticides tax |
|---|---|
| What does the tax apply to? | Individual pesticides at the point of sale |
| How should rates be calculated? | By reference to indicators of risk to human health, ecotoxicity and environmental fate for each active ingredient, by weight. |
| Are any supporting policies required? | Controls to prevent the illegal import of untaxed pesticides. A database of human health, ecotoxicity and environmental fate factors per active ingredient. |
| Is there a risk of perverse incentives? | There is some risk that farmers will opt for repeat doses of lightly taxed pesticides rather than single doses of highly taxed ones, possibly increasing resistance. This can be mitigated via farmer education. |
| Real world example | Denmark restructured its pesticide tax in this way in 2013. The intention was to achieve a 35-40% reduction in pollution load from pesticide use, which was achieved by 2018 although helped by drought conditions. To gain acceptance by farmers, Denmark recycled revenue from the tax via a reduction in land tax on farms. It also paid compensation (not based on pesticide pollution loads) to potato farmers who had been high users of pesticides with lower scope to substitute to achieve a reduction in tax. |
| Applicability in the EU | High, especially in those Member States where farmers are heavy users of highly polluting pesticides. Denmark's database of pollution loads per pesticide is transferable. |

Denmark's decision to recycle revenues from its pesticide tax to those who pay it is an example of a common approach to gaining acceptance for a new tax. The incentive to reduce pesticide use remains, but returning the money to the agriculture sector means that revenue is not available to reduce other taxation, such as labour taxes. True economic efficiency would require the merits of making payments to the agriculture sector to be considered alongside other possible tax reductions or investments which could be funded using the revenue. As is shown in section 3 above, the agriculture sector does not currently pay taxes commensurate with the pollution it causes to air and water.

### Table 17: Waste water charge

| Name of instrument | Waste water charge |
|---|---|
| What does the tax apply to? | Emissions of Biological Oxygen Demand (BOD), Nitrogen and Phosphorus from all urban waste water treatment plant and all point sources who emit directly to watercourses, without exception. |
| How should rates be calculated? | By reference to the values per Member State in Table 4 for N and P. A rate of €2/kg for BOD is suggested based on existing rates in MS which have such a tax. |

| | |
|---|---|
| Are any supporting policies required? | A tax can be collected (as in the NL below) by the body to whom payments for waste water disposal are made. |
| Is there a risk of perverse incentives? | None foreseen, provided that charges for households apply to those with and without connections to the sewerage system. |
| Real world example | In 1970 the Netherlands introduced a levy on water discharges applying to all discharges including those from waste water treatment plant. The levy was introduced following opposition to proposals for heavy State subsidies for improvements to water treatment plant. By 1996 emissions of BOD had fallen to 12% of their 1970 level. The level of the levy reflects the costs of water treatment but the costs of the sewerage system are charged for separately. |
| Applicability in the EU | High. |

A number of other Member States have introduced taxes on waste water pollution but set them at rates which are too low to be effective.

### Table 18: Water scarcity externality pricing

| Name of instrument | Water scarcity externality pricing |
|---|---|
| What does the tax apply to? | All abstractions within a river basin district (to be congruent with governance arrangements for the Water Framework Directive). |
| How should rates be calculated? | €0.30/$m^3$ (see section 2.4 for explanation) |
| Are any supporting policies required? | Metering (small abstractors can pay a flat fee although this removes their incentive to minimise abstraction). Water externality pricing should be introduced in addition to full cost recovery |
| Is there a risk of perverse incentives? | A flat rate volumetric charge does not risk perverse incentives. |
| Real world example | Luxembourg reported a volumetric charge of €0.10/$m^3$ in its second River Basin Plan. |
| Applicability in the EU | High – many Member States have Water Exploitation Indices close to or above the level which the EEA regards as indicative of water stress. |

A water externality charge may be seen as an alternative to water cap and trading (see below) but could also be combined with it.

**Table 19: Landfill and incineration tax**

| Name of instrument | Landfill and incineration tax |
|---|---|
| What does the tax apply to? | Wastes delivered to landfill sites and incinerators for disposal or recovery. |
| How should rates be calculated? | Ideally by reference to the marginal social cost of processing each different waste stream, but this is impractical. A distinction can be made, however, between inert waste – such as that from construction and demolition – and other waste, with a lower tax rate for the former reflecting lower environmental damage from decomposition into $CO_2$ and $CH_4$.<br>Tax rates may also be set by reference to the gate fees for alternative, more desirable ways of handling waste such as recycling. |
| Are any supporting policies required? | Effective deterrence of fly tipping |
| Is there a risk of perverse incentives? | None identified, but taxing landfill and not incineration may divert some waste to the latter which – depending on the waste type – may have negative environmental consequences. For example, it is generally accepted that burning plastic is more polluting than landfilling it. |
| Real world example | Austria has a combined landfill and incineration tax which is also levied on exports of waste. |
| Applicability in the EU | High. |

Waste management systems offer a number of complexities to those seeking to design taxes which make the polluter pay. A landfill and incineration tax can provide a strong incentive to the waste disposal authority to develop alternative means of waste management but the authority does not itself generate the waste and so needs a means of transmitting the price signal from the tax to those who do. Combining the tax with a pay as you throw scheme can help to achieve this.

## Table 20: Pay as you throw

<table>
<tr><th>Name of instrument</th><th>Pay as you throw (PAYT)</th></tr>
<tr><td>What does the tax apply to?</td><td>The weight or volume of waste generated by households and businesses and collected by the waste collection authorities. A study[48] has shown that charging by weight or per waste sack leads to greater reductions in waste than charging according to the volume of the waste bin itself.</td></tr>
<tr><td>How should rates be calculated?</td><td>Total revenue should at least cover the costs of collecting and processing the waste. Although the point of the scheme is to apply a marginal charge per unit of waste, it is important to include a flat fee element so that the revenue which funds waste collection and treatment is not suddenly destabilised.<br><br>Sack schemes lend themselves easily to adjustments to favour vulnerable groups, such as free nappy sacks for families with small children. They also have low administrative costs.<br><br>Weight-based schemes require up front investment in microchip technology to enable bins to be weighed and recorded as they are emptied. Such investment can however yield data which can be used to save costs by optimising collection frequencies.</td></tr>
<tr><td>Are any supporting policies required?</td><td>PAYT schemes work well in conjunction with measures to raise awareness and educate participants about ways of preventing waste.</td></tr>
<tr><td>Is there a risk of perverse incentives?</td><td>Raising the marginal cost of generating waste may lead to an increase in fly tipping which can be countered through stricter detection and deterrence.</td></tr>
<tr><td>Real world example</td><td>For example, Schweinfurt, Germany has a PAYT scheme which uses both weight and frequency to incentivise lower use of residual waste bins. As outlined in Eunomia’s 2011 report on economic instruments for waste prevention, the charging structure is comprised of the following elements: A fixed annual fee which covered the cost of collection and which varies according to the size of the residual bin chosen; a fee for emptying any bin, this emptying/removal fee is paid with the purchase price of the bag and is based on the amount of money saved by not emptying a bin; and a weight-based fee, which has declined over time. Fee rates are as follows:<br><br>
<table>
<tr><th>Bin size (litres)</th><th>Fee (€/month)</th></tr>
<tr><td>80</td><td>7.35</td></tr>
<tr><td>120</td><td>11.03</td></tr>
<tr><td>240</td><td>22.06</td></tr>
<tr><td>660</td><td>60.64</td></tr>
<tr><td>770</td><td>70.74</td></tr>
<tr><td>1100</td><td>101.06</td></tr>
</table>
<br>There is a different fee structure for bins which are shared by two neighbours. The fees for the residual bags, which can be purchased from the citizen service at the town hall, are at €3.00/65 litre sack and €5.00/110 litre sack. Collection of waste outside of the specified range also has a cost, as does green waste and bulky waste. Notably, households can also purchase additional nappy bags, to supplement the residual waste, from the municipality at a price of €1.50. There is also information on the municipality website encouraging the use of washable nappies in order to reduce fees. Households are required to register and apply for the bins they need, with a fee of €10.00 per every additional change during the year</td></tr>
</table>

[48] Study by Dijkgraaf and Gradus using data from the Netherlands Waste Management Council (AOO) for 1998, 1999 and 2000

| | |
|---|---|
| Applicability in the EU | High |

Gaining acceptance from householders for a pay as you throw scheme is crucial. Presenting it as a discount available to householders who reduce their waste is preferable to presenting it as an additional charge on those whose waste arisings are high.

**Table 21: Beverage container tax**

| Name of instrument | Beverage container tax |
|---|---|
| What does the tax apply to? | A tax per unit sold on beverage containers, paid by beverage manufacturers. |
| How should rates be calculated? | In order to incentivise higher rates of recycling, the tax should vary inversely with the % of a manufacturers containers which are returned. A tax designed this way in Norway has incentivised beverage producers to improve the return rate of their containers by setting up deposit return schemes. |
| Are any supporting policies required? | Waste collection infrastructure must enable separate collection of different waste streams (paper, glass, metal). |
| Is there a risk of perverse incentives? | No |
| Real world example | The Norwegian Government imposes an excise duty per unit of single-use beverage packaging placed on the market. There are two elements to the tax: a basic tax and an environmental tax. Packaging covered by an approved return scheme is subject to a lower environmental tax rate, depending on the return rate. For containers with a return rate less than 25%, producers pay the full amount of both taxes, but above 25%, the environmental tax is inversely proportional to the return rate. Containers with a return rate of at least 95% are exempt from the environmental tax In this way, manufacturers are incentivised to increase recovery rates for their packaging, or to use packaging that is more easily recovered in order to avoid a higher rate of tax. |
| Applicability in the EU | The tax is particularly suitable for Member States who have not yet developed widespread packaging recycling schemes. |

Taxes on activities which cause harm to biodiversity should ideally reflect the value of ecosystem services which are lost, or the cost of replacing them. Forest felling charges are an example of the latter approach.

### Table 22: Forest felling charge

| Name of instrument | Forest felling charge |
|---|---|
| What does the tax apply to? | It applies to forest owners (including the State, where applicable) and is levied on income from selling wood felled according to limits set in forest management plans. |
| How should rates be calculated? | By reference to the value of ecosystem services which are foregone when forests are felled, or the cost of replacing them. Those countries which operate a forest felling charge set rates between 2.5 - 5% of forest-related income. The majority have set their tax rates with reference to the cost of maintaining high nature value forest sites (for example, by buying stumpage rights so that sites are not re-forested), and not directly based on an appraisal of externality costs. |
| Are any supporting policies required? | A licencing system to control the extent of felling. |
| Is there a risk of perverse incentives? | Introducing a new tax without any measures in place to prevent additional felling could lead to additional felling in a rush to beat the tax. |
| Real world example | In **Bosnia and Herzegovina** forest charges of 3% of the income from wood and other forest products are applied tor cantonal (public) forestry companies and 15% to private companies managing forests. They are managed by the Forest Management Company and the federal/cantonal tax administration offices. The revenues are earmarked for reforestation of karst and bare mountainous terrains, forest protection measures, production of seedlings and research. |
| Applicability in the EU | High |

Taxes on activities which harm biodiversity are particularly hard to design where the external cost of damage varies greatly from one site to another. The two examples which follow are hypothetical and examine how taxes to deter overgrazing and peat extraction might be designed to overcome this problem.

### Table 23: Intensive livestock tax

| Name of instrument | Intensive livestock tax |
|---|---|
| What does the tax apply to? | Grazing livestock. The purpose of an intensive livestock tax is to incentivise low stocking densities at which damage to biodiversity through overgrazing is reduced. |
| How should rates be calculated? | A per hectare tax on high livestock densities, based on average grazing land owned or leased and the average number of livestock units kept. Because grazing at low stocking densities is frequently beneficial, there should be a stocking density threshold below which no tax is paid. Revenue from taxing farmers with high stocking densities could also be paid to other farmers with low ones, to reflect the fact that farming at very low stocking densities is often a marginally economic activity. |

| | |
|---|---|
| Are any supporting policies required? | Coupled headage payments funded by most Member States via the Common Agricultural Policy would need to be addressed. These would counteract any grazing tax because farmers in receipt of such payments are likely to lose funding when their herd size reduces. |
| Is there a risk of perverse incentives? | A simple scheme based solely on animal numbers and available grazing land would incentivise outdoor, extensive production systems rather than intensive ones, including indoor rearing. Careful consideration of the impact on other pollutants such as nitrates and GHGs would be required, particularly where farmers faced a choice between indoor systems with good pollutant capture and intensive outdoor rearing without. Capping the tax could help to avoid distorting the choice between two intensive systems. |
| Real world example | None. Considerable further work would be required to design such a tax. |
| Applicability in the EU | High |

A tax which incentivised a reduction in livestock numbers could lead to reductions in direct emissions of GHGs, ammonia and nitrates emissions from livestock as well as a reduction in overgrazing, provided that steps are taken to ensure that the tax does not incentivise the use of farming systems which perform less well in capturing these pollutants. The design presented here is intended as a starting point for the necessary discussions.

The existence of strong financial incentives to maintain livestock numbers, in the form of coupled payments from the Common Agricultural Policy, complicates the design of any tax. As things stand, tax rates would need to be very high in most Member States before they created a financial incentive to reduce animal numbers. This would not be the case if coupled payments were to be reduced.

In the case of peatland it is not possible to apply a replacement cost approach because peat which has been extracted, or which has been eroded as a result of drainage or afforestation, cannot be replaced. The hypothetical peat tax below is therefore based on deterring extraction.

**Table 24: Peat tax**

| **Name of instrument** | **Peat tax** |
|---|---|
| What does the tax apply to? | A volumetric tax on the extraction of peat |
| How should rates be calculated? | Ideally by reference to the value of foregone environmental services provided by the lost peat. However, valuations of such services in academic literature are extremely variable and site-specific. A tax rate could be set instead by reference to the sale value of peat itself, in order to deter all extraction. |
| Are any supporting policies required? | A system to licence peat extraction. Rights of turbary – peat cutting – exist in some Member States. A licence system could contain exemptions for household use if desired. |
| Is there a risk of perverse incentives? | An acceleration of peat extraction to beat the introduction of a new tax is possible. This risk could be minimised by phasing the tax in with a low starting rate. |

| | |
|---|---|
| Real world example | None. Peat burning is taxed in both Ireland and Finland but at rates which do not fully reflect the cost of GHG and air pollutant emissions let alone other foregone environmental services. |
| Applicability in the EU | Applicable to northern Member States with significant areas of peatland. |

## 4.2. Other market-based instruments

As well as the taxes described above, the study also investigated a number of trading schemes whereby rights to "use" environmental assets are created and allocated via a price mechanism to users. The three schemes were water cap and trade, tradeable livestock rights and biodiversity offsetting with market features. These are described in the tables below.

**Table 25: Water cap and trade schemes**

| Name of instrument | Tradeable water abstraction rights |
|---|---|
| How are tradeable rights created? | Legislation is needed to enable the water management authority to set limits on the amount of water each user may extract, with each user's water abstraction right treated as an entitlement which may be traded with other users.<br>Entitlements may be permanent or time-limited. Australia's water trading system (see below) uses a combination of permanent entitlements with annual, lower limits (allocations) based on water availability each year. |
| How are prices set? | By the market. To create a market in the first place, the water management authority must determine the maximum permissible abstraction from each water system. Prices will then reflect the balance between demand from users and supply which is the maximum permissible abstraction determined by the water authority. Prices will vary over time. |
| What regulatory infrastructure is needed? | Universal metering of users within the trading system, with a strong monitoring and compliance system. A credible scientific basis for setting the overall abstraction limit is also required. |
| Is there a risk of perverse incentives? | No. However it may be desirable to insulate some types of user from price shocks. For instance it may be felt that high water scarcity in a given year should not lead to increases in the price of drinking water. This can be achieved by giving abstraction for water a priority entitlement, with other users then sharing what is left. |
| Real world example | Australia has long-established water markets in the Murray-Darling river catchment which covers much of Eastern Australia. Users have a long term entitlement to abstract a fixed volume of water each year. They then receive an allocation each year, based on temporary water availability, which is a percentage of that entitlement. This allocation sets the limit on abstraction for the year in question. Usage must not exceed it unless additional allocation is bought from another user. That user must then ensure that its usage does not exceed its new, lower allocation. Entitlements are permanent (not varying with temporary scarcity) but may also be traded. |

| | |
|---|---|
| Applicability in the EU | Any water catchment where there is water stress |

Australia's water trading scheme is an example of a sophisticated approach which can manage peaks and troughs in demand. Tradeable permits for livestock emissions address a more stable relationship between supply and demand since neither livestock numbers nor the environment's carrying capacity for the emissions associated with livestock vary significantly from one year to the next. However, unlike water abstraction where all units of water are interchangeable, different types and breeds of livestock give rise to different levels of emissions. The Netherlands' system of phosphate trading has been designed to take account of this.

**Table 26: Tradeable permits for livestock emissions**

| Name of instrument | Tradeable permits for livestock emissions |
|---|---|
| How are tradeable rights created? | The government determines the maximum emissions which can be allowed from livestock. Permits are created representing a unit of emission (by weight) and issued to farmers. Farmers are required to hold sufficient permits to cover the emissions from the livestock they keep. These emissions vary according to factors such as breed, rearing system etc. At the end of each year the permitting authority assesses the average number of livestock each farmer has kept and checks that sufficient permits were held. There are fines if the farmer held insufficient permits.<br>Farmers are allowed to trade permits among themselves. |
| How are prices set? | By the market. The Netherlands' phosphate emissions trading system (see below) requires the permitting authority to cancel a portion of each permit which is traded, because the total number of permits currently in circulation exceeds the phosphate emissions targets applicable. |
| What regulatory infrastructure is needed? | A means of establishing how many heads of livestock, and of what type, each farmer has kept during the year. Animal tracing systems required by EU law make this relatively straightforward. |
| Is there a risk of perverse incentives? | Yes if the number of permits required is the same for all types of animal. In that instance, the trading system would provide only an incentive to keep fewer animals, rather than an incentive to keep animals whose emissions are lower which is present if a high emission animal requires more permits. |
| Real world example | The Netherlands' phosphate trading scheme. This is an emissions-based system under which farmers are required to hold sufficient permits for the number and type of bovines they keep. As well as livestock numbers, the number of permits needed is based on productive purpose, animal age and the type of stabling system used. The total number of permits is capped and farmers needing further permits must buy them from others. In its first year of operation (2018) 6% of permits changed hands. |
| Applicability in the EU | High. In addition, a trading system could be created for ammonia emissions. These are more complex than phosphate emissions, for which a broadly linear relationship exists between animal numbers and fertilizer use (which contains the phosphate). In the case of ammonia, some emissions arise from fertilizer use directly, but emissions also result from the mixing of animal urine and manure or fertilizer. These are highly dependent on |

| | |
|---|---|
| | whether or not preventative measures (such as keeping urine flows separate) are in place on the farm. An ammonia trading system could therefore be designed in which farms with good ammonia prevention systems were not required to have as many permits as those where such measures were lacking. Depending on the market-clearing price of the permits, this would provide a financial incentive to farmers to improve their ammonia management. |

A trading scheme for livestock emissions would offer an economically efficient means of achieving reductions in emissions from the livestock sector once a cap on those emissions had been set.

Biodiversity offsetting is a means of ensuring that developers whose projects result in the loss of, or damage to, habitats pay for replacement habitat. However, offsetting requirements are frequently determined by negotiation – often without transparency. Such arrangements are vulnerable to vested interests and conflicting objectives. A transparent offsetting system based on published tariffs for different types of habitat loss or damage both reduces the risk of an inappropriate offset being agreed, and enables market forces to operate both on the developer (who can see in advance how much offset his plans will require and adjust them so as to minimise it) and to provide a competitive supply of replacement habitat.

**Table 27: Biodiversity offsetting with market mechanisms**

| Name of instrument | Biodiversity offsetting with market mechanisms |
|---|---|
| How are tradeable rights created? | A government creates a market in habitat restoration by requiring developers who remove or damage habitat in the course of their development to replace it themselves or pay for it to be restored by others. The market is made possible by having a fixed tariff for each unit (e.g. a hectare) and type (e.g. species-rich grassland) of habitat loss or damage. The developer is not required to replace damaged habitat like for like, but to provide replacement habitat with the same unit value. If the government also encourages the development of a market in habitat restoration, developers can know the price of restoration and in this way the cost of their development will be internalised. In a simplified system such as Luxembourg's, the government is the only seller of restoration credits and so the price is fixed. |
| What regulatory infrastructure is needed? | A robust system of development control. A strong science base from which to calculate the tariffs applicable to different types of habitat loss. |
| Is there a risk of perverse incentives? | Since uncertainty is a cost to developers, there is a risk that the introduction of fixed tariffs from which a developer can identify his offsetting costs in advance will increase the attractiveness of development and so lead to additional habitat loss. This is only problematic if the replacement cost of habitat has been set too low. |
| Real world example | Luxembourg's ecopoints system requires developers to assess the cost to biodiversity of their proposed development using a fixed tariff of costs per unit (e.g. hectare) of lost habitat of a wide range of types. Developers must compare the ecopoints value of the site before and after development and pay any difference to the government. The government must use its receipts to fund habitat restoration in the same region of Luxembourg. |
| Applicability in the EU | High – offsetting systems exist in other Member States but lack transparency. |

Offsetting is often regarded as controversial. The proposal here is that offsetting systems – if they exist – should contain market features and especially a transparent means of determining what quantum of offsetting should take place.

The analysis in this section shows that a wide range of taxes and other MBIs is available through which polluters could be made to pay a more realistic share of the costs they impose on the rest of society. Shifting some of the burden of taxation from labour taxes to environmental ones – as committed to by EU Ministers in 2011, but not yet achieved – is strongly supported by the findings of this study. However, it has so far not happened on any significant scale. A reason frequently given by opponents of such a shift is that environmental taxes and charges are bad for growth and jobs, and regressive in their impact on the income distribution. The next section of the report therefore tests these claims by modelling the macroeconomic impacts of implementing a package of such measures across the EU.

# 5. The macroeconomic impacts of environmental tax reform

This chapter describes results from modelling exercises of the macroeconomic impacts of various polluter pays economic instruments using a National Accounts-based econometric model, E3ME, as described in Box 2. Results were found for both Member State and instrument-specific scenarios and a stylised EU-wide scenario.

**Box 2: The E3ME model**

E3ME is a global macro-econometric model of the world's economic, energy systems and the environment, developed and maintained by Cambridge Econometrics. It was originally developed through the European Commission's research framework programmes and is now widely used in Europe and beyond for policy assessment, for forecasting and for research purposes. It enables detailed analysis and simulation of sectoral and country level impacts (such as on jobs, output, incomes, energy demand, emissions, fuel use, material consumption and prices) from a wide range of scenarios, with the ability to model interactions between variables.

The current version of the model includes all major world economies, 70 industry sectors (45 for non-EU), 43 categories of household expenditure (28 for non-EU), 22 different users of 12 different fuel types, 14 different users of 7 different raw materials, and 14 types of airborne emissions (where data are available) including the 6 greenhouse gases monitored under the Kyoto protocol.

The main data sources are Eurostat, the OECD (both the National Accounts section and STAN), World Bank, UN, International Monetary Fund (IMF) and International Labour Organisation (ILO), supplemented by data from national sources. Energy and emissions data are sources from the International Energy Agency (IEA) and EDGAR global emissions database. Gaps in the data are estimated using customised software algorithms.

## 5.1. Instrument-specific scenarios

As the basis for the modelling, the study team first identified a short list of polluter pays economic instruments – drawing from the analysis described in section 4 – that could be implemented in EU Member States to further address particular areas of environmental concern, as listed in Table 28. The instruments were chosen to ensure that the five thematic areas included in the study scope were covered, that they are representative of existing experience across the EU-27 and can be practically implemented, that they are relatively easy to model, and that they can help to support implementation of the EU environmental *acquis* whilst also having the potential to generate positive economic impacts.

## Table 28: Summary of selected polluter pays economic instruments

| Thematic area | Market-based instrument (MBI) | Member State(s) |
|---|---|---|
| Air pollution | NOx tax | • Austria<br>• Germany<br>• Netherlands |
| | Indirect tax on domestic biomass fuel and coal | • Bulgaria<br>• Hungary<br>• Poland<br>• Slovakia |
| Waste, resources, and circular economy | Landfill tax | • Cyprus<br>• Greece<br>• Lithuania |
| | Pay-As-You-Throw | • Cyprus<br>• Estonia<br>• Greece<br>• Latvia<br>• Malta<br>• Romania<br>• Slovakia |
| Water quality & marine litter | Pesticide tax | • Austria<br>• Belgium<br>• Luxemburg<br>• Slovenia<br>• Sweden |
| | Fertiliser levy | • Czech Republic<br>• Denmark<br>• Estonia<br>• France |
| | Waste water pollution taxes | • Ireland<br>• Romania |
| Water stress & availability | Water consumption charge | • Bulgaria<br>• Cyprus<br>• Czech Republic<br>• Germany<br>• Greece<br>• Italy<br>• Malta<br>• Poland<br>• Portugal<br>• Spain |
| Biodiversity & land-use management | Intensive agriculture tax | • France<br>• Ireland<br>• Netherlands<br>• Portugal |
| | Forest felling charge | • Latvia |

In each case, model runs were performed based on three scenarios, in which:

- Revenues were used to pay-down government debt;
- Revenues were recycled in the form of labour tax reductions; and
- Revenues were recycled in a bespoke manner, according to the particular circumstances of the Member State and instrument (for example, for investment in renewable energy technology, or to reduce social security contributions).

These scenarios were compared against a business-as-usual baseline assuming no additional environmental taxes, and results given in terms of the impact on GDP, employment, real household income (across income quintiles) and trade. The detailed results related to each instrument are provided in Annex 6, although some general conclusions can be drawn.

Firstly, it is clear that the net macroeconomic impact from introducing an individual polluter pays instrument tends to be small – for most of the assessed measures the change compared to the baseline in all indicators is below 0.1%. Only for the PAYT and the fertiliser levy, for Greece in the case of a landfill tax, and for Bulgaria in the case of the water consumption charge, the percentage change relative to baseline exceeds 0.1%.

Secondly, how additional tax revenues are used is a driver of macroeconomic outcomes. In most cases, the scenario with bespoke revenue recycling or reduced income taxation leads to more favourable outcomes in terms of GDP compared to a scenario with debt reduction. In the case of the forestry felling charge and the NOx tax, for example, the magnitude of the difference to baseline visibly increases in the bespoke revenue recycling variant, while the effects in the scenario with debt reduction remain minor.

Thirdly, employment results broadly mirror GDP results. Nonetheless, revenue recycling does not always lead to more favourable employment outcomes; these predominantly depend on the chosen revenue recycling option. In the scenario for the pesticide tax (for Sweden and Slovenia), the fertiliser levy (for all Member States) and the intensive agriculture tax (for France and Portugal), the model suggests that a reinvestment of revenues into the agriculture sector induces investment in technological innovation primarily, thus reducing employment in agriculture over time.

Fourthly, the impact on real incomes varies across scenarios and Member States. Overall, the polluter pays economic instruments negatively affect real incomes for all households if the income is used to reduce debt, but increases income for all households if the revenues are recycled. The direction of impact is similar for all income quintiles and the differences between income quintiles are generally small.

Nonetheless, as modelled in this study, a PAYT, a NOx tax, and a fertiliser levy tend to affect higher income households more than lower income quintiles. Conversely, an indirect tax on domestic biomass fuel and coal, a waste water pollution tax, a tax on intensive agriculture, and a water consumption tax tend to affect lower income households more than higher income households. The ultimate impact on household income will however depend on the specific instrument design.

Fifthly, both exports and imports tend to be lower than baseline values as a result of environmental taxation, which increases export prices and reduces economic activity. However, the magnitude of change is higher for imports due to reduced consumer spending overall. How revenue use alters these trade effects differs widely across countries and across instruments, depending on how the chosen revenue use affects demand for foreign goods and services, as well as depending on policy choices in trading partners.

## 5.2. The EU-wide scenario

In addition to the instrument-specific modelling, a sylised EU-wide scenario was modelled in order to give an indication of the direction and order of magnitude of macroeconomic impacts of a broader package of environmental tax reform implemented across the EU.

In this scenario, all ten of the polluter pays economic instruments identified above were applied to all Member States (using average tax rates in those Member States where specific rates were not identified in the instrument-specific scenarios), and revenue was recycled in all Member States to reduce labour taxes. Evidently, alternative assumptions regarding tax rates or revenues use would produce different economic, labour market, trade, and distributional outcomes.

It is worth noting that these instruments raise a relatively modest €30 billion per year by 2030 across the EU, which remains well below the externality cost of the pollutants they concern, and would increase the share of environmental taxation in the EU from approximately 6% today to just 6.5% by 2030. This reflects a design choice to initially set instrument rates at relatively low levels which could subsequently be increased over time, an approach which has been found to be an important element of effective environmental tax reform49. We can assume that the macroeconomic effects of larger packages would increase, possibly proportionately, but this would need to be further examined.

Overall the results from the EU-wide scenario suggest that a portfolio of polluter pays instruments in combination with a reduction in income taxation could generate positive impacts for GDP, employment and household incomes for the EU economy as a whole, albeit with some significant variation among Member States. Headline findings are discussed below.

### 5.2.1. Impact on GDP and employment

Both GDP and employment in the scenario are projected to be higher than in the baseline, throughout the projected time period to 2030. Using the €30 billion of revenues to reduce income tax generates a net positive GDP impact of €35 billion, offsetting the initial negative impacts of environmental taxation, and creating 140,000 additional jobs. By 2030, the EU's GDP is projected to be around 0.2% higher than GDP in the baseline, while employment is projected to be around 0.1% percent higher employment than in the baseline.

[49] See for example: https://www.oecd.org/env/tools-evaluation/48164926.pdf

**Table 29: Change in GDP and total employment - % difference from baseline**

| | 2025 (GDP) | 2030 (GDP) | 2025 (Employment) | 2030 (Employment) |
|---|---|---|---|---|
| Estonia (EE) | 1.7% | 1.6% | 0.5% | 0.5% |
| Latvia (LV) | 1.5% | 1.7% | 0.1% | 0.3% |
| Lithuania (LT) | 1.3% | 1.4% | 0.1% | 0.1% |
| Cyprus (CY) | 0.7% | 0.7% | 0.2% | 0.3% |
| Poland (PL) | 0.7% | 0.7% | 0.1% | 0.0% |
| Czech Rep. (CZ) | 0.6% | 0.5% | 0.1% | 0.1% |
| Greece (EL) | 0.6% | 0.5% | 0.2% | 0.1% |
| Slovenia (SI) | 0.6% | 0.7% | 0.1% | 0.1% |
| Hungary (HU) | 0.5% | 0.5% | 0.2% | 0.2% |
| Malta (MT) | 0.5% | 0.4% | 0.2% | 0.1% |
| Romania (RO) | 0.4% | 0.5% | 0.0% | 0.1% |
| Croatia (HR) | 0.4% | 0.2% | 0.0% | 0.0% |
| Bulgaria (BG) | 0.4% | 0.6% | −0.1% | 0.0% |
| Finland (FI) | 0.4% | 0.5% | 0.2% | 0.2% |
| Luxembourg (LU) | 0.3% | 0.1% | 0.1% | 0.0% |
| Ireland (IE) | 0.3% | 0.2% | 0.3% | −0.2% |
| Austria (AT) | 0.3% | 0.3% | 0.1% | 0.1% |
| Portugal (PT) | 0.3% | 0.3% | 0.0% | 0.1% |
| France (FR) | 0.3% | 0.2% | 0.0% | 0.0% |
| Denmark (DK) | 0.2% | 0.2% | 0.1% | 0.0% |
| Spain (ES) | 0.2% | 0.4% | 0.2% | 0.3% |
| **EU27** | 0.2% | 0.2% | 0.1% | 0.1% |
| Slovakia (SK) | 0.2% | 0.2% | 0.0% | 0.0% |
| Sweden (SE) | 0.2% | 0.2% | 0.1% | 0.0% |
| Italy (IT) | 0.2% | 0.1% | 0.0% | 0.0% |
| Netherlands (NL) | 0.2% | 0.0% | 0.1% | 0.1% |
| Germany (DE) | 0.0% | 0.1% | 0.0% | 0.0% |
| Belgium (BE) | 0.0% | 0.0% | 0.0% | 0.0% |

Although the results are sensitive to the assumptions made (e.g. size of the shock, combination of MBIs, and how revenues are used etc), they suggest that environmental tax reform can bring about positive macroeconomic impacts on the EU economy.

On the one hand, the assumed combination of MBIs in the scenario leads to higher industry and consumer prices in certain areas of the economy, resulting in loss of competitiveness, lower consumer spending and lower extra-EU exports. On the other hand, the assumed combination of MBIs in the scenario may result in a reduction in energy and material imports and higher investment in response to the cost increase while reduced income taxation boosts consumer spending and employment.

Throughout the scenario analysis, impacts on different Member States vary for a wide variety of reasons. These include differences in the energy mix, labour market structure, income levels, and whether changes in demand affect domestic or foreign suppliers.

### 5.2.2. Impact on real incomes

The scenario results suggest that it is possible to increase real incomes through environmental tax reform in all Member States. By 2030, real incomes in the EU are projected to increase by 0.3% on average, relative to the baseline for the same year. As a result of the simulated portfolio of MBIs in the scenario, price inflation, propagated through higher industry costs and prices, exerts a downward pressure on real incomes, while lower income taxation rates and higher employment exerts upward pressure. The latter effects dominate the former effect, resulting in higher real incomes in 2030 relative to baseline values.

**Table 30: Change in real income in 2030 (% difference to baseline)**

| | All households | First quintile | Second quintile | Third quintile | Fourth quintile | Fifth quintile |
|---|---|---|---|---|---|---|
| Estonia (EE) | 2.8% | 2.6% | 2.5% | 2.6% | 2.8% | 2.9% |
| Latvia (LV) | 2.1% | 1.8% | 1.7% | 1.8% | 2.1% | 2.3% |
| Cyprus (CY) | 1.2% | 1.0% | 1.1% | 1.1% | 1.2% | 1.3% |
| Bulgaria (BG) | 1.1% | 1.2% | 1.2% | 1.1% | 1.1% | 1.2% |
| Slovenia (SI) | 1.1% | 0.9% | 0.8% | 0.9% | 1.1% | 1.2% |
| Hungary (HU) | 1.0% | 0.9% | 1.0% | 1.0% | 1.0% | 1.1% |
| Czech Rep. (CZ) | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% | 0.9% |
| Lithuania (LT) | 0.9% | 0.9% | 0.7% | 0.7% | 0.9% | 0.9% |
| Finland (FI) | 0.8% | 0.9% | 0.9% | 0.8% | 0.9% | 0.8% |
| Malta (MT) | 0.8% | 0.6% | 0.6% | 0.6% | 0.9% | 1.0% |
| Poland (PL) | 0.8% | 0.7% | 0.6% | 0.7% | 0.8% | 0.9% |
| Romania (RO) | 0.7% | 0.5% | 0.5% | 0.6% | 0.7% | 0.8% |
| Slovakia (SK) | 0.6% | 0.5% | 0.5% | 0.5% | 0.6% | 0.7% |
| Greece (EL) | 0.6% | 0.6% | 0.6% | 0.6% | 0.6% | 0.5% |
| Portugal (PT) | 0.5% | 0.6% | 0.5% | 0.5% | 0.5% | 0.5% |
| Austria (AT) | 0.4% | 0.5% | 0.5% | 0.4% | 0.5% | 0.4% |
| Luxembourg (LU) | 0.4% | 0.5% | 0.4% | 0.4% | 0.4% | 0.4% |
| Ireland (IE) | 0.4% | 0.3% | 0.4% | 0.4% | 0.4% | 0.4% |
| Sweden (SE) | 0.4% | 0.5% | 0.5% | 0.4% | 0.4% | 0.4% |
| Spain (ES) | 0.3% | 0.4% | 0.4% | 0.3% | 0.4% | 0.3% |
| **EU27** | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Denmark (DK) | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Netherlands (NL) | 0.3% | 0.4% | 0.3% | 0.3% | 0.3% | 0.3% |
| Germany (DE) | 0.2% | 0.3% | 0.3% | 0.3% | 0.2% | 0.2% |
| Belgium (BE) | 0.2% | 0.3% | 0.3% | 0.2% | 0.2% | 0.2% |
| France (FR) | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |
| Italy (IT) | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% |
| *Data for HR not available | | | | | | |

Comparing changes in real income across different MS reveals an interesting pattern. Table 30 shows that all income groups in all Member States experience an increase in real incomes, but these positive impacts are not evenly shared. On the one hand, and contrary to general understanding that environmental taxation as well as income tax reduction would have regressive effects, the scenario results suggest an improvement in income distribution for many Member States.

On the other hand, the model projects regressive effects from the portfolio of instruments in some other Member States, whereby the income increases in lower income quintiles by a slightly smaller percentage than that of the higher income quintiles, suggesting a change in relative income distribution. However, the general picture is that differences are not marked and whether environmental taxes are progressive or regressive will depend largely on instrument design.

### 5.2.3. Impact on trade

Net effects on extra-EU trade are small, with both imports and exports being lower than baseline values. Environmental taxes are projected to increase input costs and thus reduce imports for all industries. The largest decrease is chemical imports across the EU, which is linked to the agriculture sector (and other sectors) buying less from this sector (i.e. less pesticide and fertiliser). In turn, exports fall due to higher input costs and increases in industry and consumer prices for goods produced within the EU. Overall, this suggests an improvement in the EU's balance of trade. More detail on the potential trade impacts is included in Annex 6.

## 5.3. Addressing myths about green taxation

Despite the various high-level calls by a range of EU stakeholders – as discussed in section 1 – for shifting taxes from labour to the environment, and the seemingly compelling evidence of the economic, environmental and often social equity benefits of doing so, it is striking that such little progress has been made with regard to extending polluter pays economic instruments in the EU in the last decade.

Based on the analysis of polluter pays instruments summarised in section 4 as well as those assessed in the Polluter Pays Toolkit accompanying this report, and complemented by the macroeconomic modelling results presented in section 5, it is possible to dispel some common myths about so-called 'green taxes' and other polluter pays economic instruments that may be standing in the way of their wider adoption, as explored in Table 31.

**Table 31: Responses to common myths about 'green' taxation**

| Myth | Response |
|---|---|
| Green taxes are regressive | Higher consumption by higher income households means they will pay more in green taxes in absolute terms, but because green taxes tend to represent a higher proportion of the income of lower income households, they are generally considered to be socially regressive. This can undermine their social and political acceptability, especially if alternative options are not available for people to change their behaviour.<br><br>However, green taxes can be progressive if lower income households are exempted, or depending on the use of the tax revenues. Lower-income households can benefit most if revenues are returned as lump-sum payments (as in British-Colombia), or if revenues are used to fund progressive labour tax cuts (similar to the modelling in this study), or if revenues are used for targeted technological investments (such as energy efficiency measures, or public transportation) to support behaviour change in lower income households, for example. |
| Green taxes don't work | There are many examples of environmental success, such as Sweden's NOx tax, Denmark's pesticide tax, Czechia's air pollution industry charge, or France's |

| | |
|---|---|
| | incentive charging for waste. Charging for plastic bags has had a dramatic impact on their use across the EU.<br><br>As with the distributional consequences of green taxes, instrument design is key. For instance, the rate of tax must be high enough to influence behaviour, while implementation as part of a broader package of supportive policy measures (such as the landfill tax combined with a ban on landfilling of recyclable waste in Austria and the Netherlands) will always be more effective. |
| Green taxes do work but this means they won't generate revenues in the long-run | Given that one of the objectives of green taxes and other types of green pricing instruments is to encourage consumer or business behaviour change, the revenues from such schemes can be expected to decline over time (assuming it is cheaper to change behaviour than to pay the tax). This leads some stakeholders to conclude that such measures are not a long-term, sustainable source of government revenues.<br><br>While this trend can certainly be observed in some cases, such as the declining revenues raised from the plastic bag levy in Ireland, there are two ways in which such concerns may be addressed. Firstly, governments may choose to increase tax rates over time – as was the case with the NOx tax in Sweden, the municipal waste and incineration charge in Catalonia, Spain, the waste tax in the Netherlands, the landfill tax in Greece, the waste disposal charge in Estonia or the air pollution fee in Czechia, for example. Alternatively, governments may choose to expand the environmental tax base by introducing new polluter pays instruments, as assessed in this study. |
| Green taxes are bad for business competitiveness | Taxation and other pricing instruments can lead to higher production costs that put companies at a disadvantage compared to their competitors who are not subjected to such a tax. Such impacts are, however, highly context-specific, and can be addressed through careful policy design.<br><br>A good example of careful policy design to address competitiveness concerns is the pesticide tax in Denmark, which has helped to decrease pesticide loads and protect water quality. Many farmers feared that the tax would hit production of specialty and high value crops in Denmark. However, the Danish Ministry of Environment conducted an evaluation of the effects of the tax and concluded that this was not the case. Pesticide costs measured as a share of gross dividend remained constant and decreases in certain crops were found to be due to other factors. Where there were justified concerns, as in the case of potatoes, the government reduced another tax in compensation and redirected part of the revenue from the pesticide tax into a dedicated fund. |
| Green taxes are unpopular | The introduction of environmental pricing instruments – like many forms of highly visible taxation – can easily attract opposition. Protests from stakeholders, whether business groups or citizens, can often lead to watering-down of measures.<br><br>This was the case, for example, with freezing the rate of the waste disposal tax in Estonia, greatly limiting its efficacy, and with the introduction of the Forest Public Benefit Function Fee in Croatia, which attracted much opposition due to the lack of public awareness of the objective of the fee, or clarity about what the revenue was being used for.<br><br>But one way to address public concerns is through meaningful stakeholder consultation and engagement in the design and implementation of green pricing measures.<br><br>• For example, a scheme that works much better to protect forests is the Sèlvans scheme in Catalonia, Spain. Stakeholder involvement has been promoted actively and supported with scientific evidence. Sèlvans has |

| | |
|---|---|
| | been successful both in attracting public administration and private donors' attention to the instrument and its mission, and in engaging with landowners and establishing a varied and flexible range of effective instruments and agreements.<br><br>• In Finland, significant consultation processes helped the DRS and packaging tax to achieve widespread support among stakeholders, albeit requiring an initial reduction in the recycling target from 90% to 80%.<br><br>• In Romania, a careful stakeholder consultation process, including conferences involving business and civil society actors, was critical to building understanding and support for the introduction of a deposit-refund scheme. |

# 6. Conclusions

The cost imposed by pollution and other forms of environmental damage greatly exceeds the revenues generated from taxes and other economic instruments addressing such polluting activities – for all pollutants, in all Member States and across all sectors of the economy. The evidence for this is strongest in the case of air pollution, GHGs and water pollution for which good data on both costs and emissions is available across the EU, but more localised evidence about other forms of environmental damage tells the same story.

Based on our calculations, the costs of air pollution, GHGs and water pollution alone amount to at least €750 billion per year across the EU – in excess of the annual national GDP of 23 EU Member States[50] or equivalent to the combined annual GDP of Finland and Sweden. Polluters are charged only 44% of the cost of air pollution and GHGs, whilst water polluters pay almost nothing. At national level taxation of waste management is uncommon and local waste management charges tend to reflect just the cost of providing the service rather than a share of the €420 billion external cost.

Evidence collected through case studies also shows very high and untaxed externality costs for water scarcity and the inappropriate management of biodiversity. A fair tax to cover the external cost of abstracting water in the five sub-regions we studied, for example, would need to raise €4 – 5 billion compared to the €90 – 112 million that is currently collected in these sub-regions.

These internalisation rates are almost certainly under-estimates. Our figures for the cost of pollution are under-estimates because costings are not available for all types of pollutant and all impact pathways, while our revenue estimates may in some respects overstate how much polluters are paying towards these costs, because in some cases it is not possible to separate user charges from genuine externality taxes.

There is clearly scope to apply the polluter pays principle more rigorously through environmental taxation and other economic instruments in the EU. Many stakeholders have called across the last decade for a shift in taxation from labour to the environment which could help to achieve this. This study explored ten different types of tax or other economic instruments which Member States could consider introducing in order to raise the share of government revenues from environmental taxes and charges while reducing labour costs.

Macroeconomic modelling of an EU-wide scenario for this study – in which all ten taxes are introduced by all Member States – shows that higher environmental taxes, with revenues used to reduce labour taxes, would have positive impacts on growth, jobs and real incomes, and would not have a regressive impact on the income distribution at EU level. Although a very moderately regressive impact (in which the real incomes of lower income groups rise less than those on higher incomes) was found in some Member States, this could be addressed with careful policy design such as more targeted labour tax cuts for lower income earners.

Given the scale of the costs being caused by pollution and other forms of environmental damage, and the positive economic results that could be achieved through a careful shift of taxation from labour to the environment, it is time for EU governments to re-commit to the environmental tax reforms needed to make the polluter pays principle a reality in the EU.

[50] All of the EU27 Member States except for Germany, Spain, France and Italy.

Publications Office
of the European Union