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Preface

This third OECD Environmental Performance Review confirms that Sweden remains a front-runner in environmental policy and has developed approaches that will be of interest to other countries. However, the report highlights that Sweden will have to step up its efforts if it is to achieve its ambitious environmental targets, including the goal of zero net greenhouse gas emissions by the second half of the century. The burden of achieving these objectives will also have to be more equitably shared to maintain the necessary high level of public support.

The Swedish people have long placed a high value on protecting the environment. Relatively high income and low inequality have underpinned the implementation of ambitious policies by successive Swedish governments. As a result, the population appears to be more satisfied with its country's environmental quality than people in other European countries. Air and water quality is generally good. Less than 1% of waste is disposed of in landfills, while the rates of recycling and recovery are high. Protected areas have expanded and now cover 14% of the country's surface and 6% of marine waters.

A notable feature of Swedish environmental policy has been the successful use of environmentally related taxes. Sweden was among the first countries to introduce a carbon tax, and one of the few countries to have successfully implemented a green tax shift by reallocating the tax burden from labour to environmentally harmful activities. These incentives to reduce pollution, combined with strong support for innovation, have helped foster green technologies. In recent years, Sweden has been among the most innovative OECD countries in environment-related technology.

Despite such generally good environmental performance, Sweden still faces a range of environmental challenges, some unique, others shared with other countries. For instance, the way environmental objectives are defined at different levels of government is not always consistent or coherent. Less costly policy instruments could be used. Some habitats and species could be better protected. And, as one of nine Baltic Sea countries, Sweden and its neighbours need to do more to protect this vulnerable ecosystem.

This Review presents 27 Recommendations to help address these challenges. It suggests, for example, ways to make Sweden's system of Environmental Quality Objectives more effective; it recommends extending the use of environmentally related taxes and pricing instruments, especially in areas other than energy use; and it calls for developing a strategic action plan for achieving climate targets, as well as an overarching marine environment strategy.

This review is the result of a constructive policy dialogue between Sweden and the other members and observers of the OECD Working Party on Environmental Performance.

In addition to the support provided to Sweden, I am confident that this collaborative effort will help to improve the management of the environmental challenges faced by other OECD member and partner countries.

Angel Gurría

OECD Secretary General

Foreword

The principal aim of the OECD Environmental Performance Review programme is to help member and selected partner countries improve their individual and collective performance in environmental management by:

- *helping individual governments assess progress in achieving their environmental goals*
- *promoting continuous policy dialogue and peer learning*
- *stimulating greater accountability from governments towards each other and public opinion.*

This report reviews the environmental performance of Sweden since the previous OECD Environmental Performance Review in 2004. Progress in achieving domestic objectives and international commitments provides the basis for assessing the country's environmental performance. Such objectives and commitments may be broad aims, qualitative goals or quantitative targets. A distinction is made between intentions, actions and results. Assessment of environmental performance is also placed within the context of Sweden's historical environmental record, present state of the environment, physical endowment in natural resources, economic conditions and demographic trends.

The OECD is indebted to the government of Sweden for its co-operation in providing information, for the organisation of the review mission to Stockholm and Gothenburg (22-28 September 2013) and for facilitating contacts both inside and outside government institutions.

Thanks are also due to all those who helped in the course of this review, to the representatives of member countries participating in the OECD Working Party on Environmental Performance and especially to the examining countries: Korea, Norway and the United Kingdom. The team that prepared this review comprised experts from reviewing countries: Ms SoEun Ahn (Korea), Ms Mai-Britt Knoph (Norway) and Mr Alex Bowen (United Kingdom); members of the OECD Secretariat: Ms Ivana Capozza, Mr Brendan Gillespie, Mr Eugene Mazur, Ms Alexa Piccolo and Ms Frédérique Zegel; and Mr Joseph Curtin and Ms Ingrid Kelling (consultants). Ms Carla Bertuzzi, Ms Jennifer Calder and Ms Clara Tomasini (OECD Secretariat) and Mr Mark Foss (consultant) provided statistical and editorial support during the preparation of the report. Preparation of this report also benefited from comments provided by other members of the OECD Secretariat.

The OECD Working Party on Environmental Performance discussed the draft Environmental Performance Review of Sweden at its meeting on 27 March 2014 in Paris, and approved the Assessment and Recommendations.

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General notes

Signs

The following signs are used in Figures and Tables:

. . : not available

– : nil or negligible

. : decimal point

Country aggregates

OECD Europe: This zone includes all European member countries of the OECD, i.e. Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

OECD: This zone includes all member countries of the OECD, i.e. the countries of OECD Europe plus Australia, Canada, Chile, Israel*, Japan, Korea, Mexico, New Zealand and the United States.

Country aggregates may include Secretariat estimates.

Currency

Monetary unit: Swedish krona (SEK).

In 2013, USD 1.00 = SEK 6.474.

Cut-off date

This report is based on information and data available up to the end of January 2014.

* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Executive summary

Sweden's environmental quality is generally very good

Sweden has a sound, innovation-oriented economy built on rich reserves of timber, iron ore and hydropower, a strong industrial base and a highly skilled labour force. The population enjoys a high standard of living thanks to high income, low inequality and good environmental quality. Water supply, wastewater treatment and waste management services reach high standards. Less than 1% of municipal waste is disposed of in landfills, while the rates of recycling and recovery are high. However, generation of municipal waste grew by 16% between 2000 and 2012. The carbon intensity of the economy is the second lowest among OECD member countries as renewables and nuclear energy cover more than two-thirds of Sweden's energy needs. Emissions of greenhouse gases (GHGs) have declined and have been decoupled from economic growth. Emissions of most air pollutants have also decreased and air quality is generally good, with just a few exceptions in some cities. Protected natural areas have been expanded to reach about 14% of land area and inland waters and 6% of marine waters, although the conservation status of some habitats and species is relatively unfavourable. Several freshwater bodies, most marine ecosystems and the Baltic Sea suffer from eutrophication.

Sweden has a long history in environmental policy

Sweden has created a system of ambitious environmental quality objectives (EQOs), which constitutes a major society-wide undertaking towards sustainable development. However, it does not establish policy priorities commensurate with available resources, which has reduced the effectiveness of actions. Most of the EQOs will not be reached by the 2020 deadline. Sweden has a long tradition of open, free access to environmental information and of public participation in decision making. Sweden compares well with other countries in contributing to the development of EU environmental legislation and in implementing it. Integrated environmental permitting and environmental impact assessment procedures are well developed. However, the institutional autonomy of the county and local governments, differences in their implementation capacity and the influence of local interests have resulted in inconsistencies in implementation and enforcement. There is still insufficient integration of environmental concerns into municipal spatial planning. A significant share of environmental violations go essentially unpunished. Clarifying the boundary between administrative and criminal offences would help close this enforcement gap.

Pricing instruments such as taxes and charges are at the core of Swedish environmental policy

Sweden was among the first to introduce a number of environmentally related taxes in the early 1990s, including a tax on emissions of carbon dioxide (CO_2). Waste and water charges are used countrywide to cover service costs. Other instruments have been introduced in the last 10 years, including a landfill tax, CO_2-based vehicle taxes and congestion charges in Stockholm and Gothenburg. Sweden is one of the few countries that managed to implement a "green tax shift", reallocating the tax burden from labour to environmentally harmful activities. There is evidence that tax and pricing instruments have contributed to reducing environmental externalities and promoted the adoption of cleaner technologies. However, much of the progress in environmental taxation dates back to the 1990s or early 2000s. It would be timely to consider further extending the use of environmentally related taxes and pricing instruments, especially in areas other than energy use, while reducing other taxes. Despite recent progress in phasing out exemptions from energy and carbon taxes, several remain that can reduce the incentives to use energy efficiently. Other measures, including generous tax treatment of company cars and commuting allowances, run counter to environmental and climate mitigation objectives.

Sweden has invested in the environment to promote innovation and growth domestically and internationally

Several direct subsidy programmes have encouraged businesses and households to make environment-friendly investments such as in the area of energy efficiency and renewables. Industry expenditure for environmental protection has significantly increased. However, the net benefits of support mechanisms are unclear and their budget reporting could be improved. With 1% of its gross national income given as official development assistance, Sweden is among the most generous OECD donors. More than half of its bilateral aid is environment-related.

Sweden is among the most eco-innovative OECD member countries. Since the mid-2000s, the government's research and development budgets for environment and energy have grown in support of Sweden's environmental objectives. However, the multiplicity of funding bodies and programmes makes it difficult to identify the best funding opportunities, especially for small and medium-sized enterprises. The environmental goods and services sector has grown rapidly, but it remains relatively small. There is scope for better focusing support on industries at risk of losing their competitive advantage because of a low rate of green innovation activity.

Sweden aims to maintain its leadership role in addressing climate change

GHG emissions have declined by 16% since 2000, allowing Sweden to significantly overachieve its Kyoto Protocol target. The climate policy mix has strongly relied on market-based approaches, namely the carbon tax and the EU emission trading system (EU-ETS). A tradable electricity certificate system has effectively promoted the use of

renewables, which already exceed Sweden's renewables target for 2020. However, there are wide differences in carbon prices across the economy. As a result, GHG emissions have been mainly reduced in sectors where carbon prices are higher, namely the residential sector, while cheaper abatement options may have been missed. Sweden should assess whether overlaps among the EU-ETS and the other policy measures result in higher costs of climate mitigation and in displacing GHG emissions to other countries. Many of the low-cost approaches for curbing GHG emissions have already been deployed. To avoid excessively high costs and maintain political support, Sweden will have to implement more cost-effective policies, allocate compliance costs more equitably and further encourage technological change. This is all the more important as Sweden established ambitious objectives to reduce GHG emissions in the medium and long term.

Tackling GHG emissions from transport is a challenge

Transport is the largest source of GHG emissions in Sweden, accounting for about one-third of the total. This underlines the size of the challenge of achieving the goal of a fossil-fuel independent vehicle fleet by 2030. Several measures have helped reduce emissions from passenger vehicle use in the second half of the 2000s, including the carbon tax, vehicle taxes, subsidies for cleaner vehicles, biofuels tax exemptions, and congestion charges. However, emissions from heavy goods vehicles have increased since 2000. Further measures are needed to better internalise the environmental costs of road freight transport. Sweden should systematically evaluate the incentive mix in the transport sector and ensure that transport investments are consistent with climate policy objectives.

Sweden's marine environment is a key asset, but it comes under increasing pressures

As one of the nine Baltic Sea countries, Sweden attaches great importance to the marine environment and actively engages in related international and regional initiatives. Despite significant efforts, progress in combating eutrophication, pollution from toxic substances and overfishing in the Baltic Sea has been limited; and new pressures are emerging, including climate change, ocean acidification and invasive alien species. Several economic sectors (including shipping, fishing, coastal industry and tourism) contribute to Sweden's economy and employment, but also exert pressures on marine ecosystems. More could be done to take account of the conservation and sustainable use of marine ecosystems as policies in these sectors are developed.

Managing the marine environment requires an ecosystem approach and a wide range of measures

The establishment of the Swedish Agency for Marine and Water Management in 2011 provides an opportunity to streamline the main marine programmes and improve policy coherence. While Sweden has extended the marine areas under protection, further efforts are needed to achieve the 2020 Aichi target and ensure effective management of these areas. Sweden has participated in pilot marine spatial planning projects for the Baltic Sea.

However, to date, only a few of the 85 coastal municipalities have included marine areas in their comprehensive spatial plans. Sweden has effectively implemented taxes and charges to reduce water and sea pollution. Yet there is scope to expand the use of economic instruments and payment for ecosystem services in marine areas. Like many other countries, Sweden is at a very early stage of implementing the ecosystem approach in its marine policy. Despite considerable progress, there are still important data gaps. As scientific understanding improves, the economic evaluation of marine ecosystem services should be strengthened to better support policy makers in identifying priorities and addressing trade-offs.

PART I

Progress towards sustainable development

PART I

Chapter 1

Key environmental trends

With high per capita income, low inequality rates and good environmental quality, Sweden's population enjoys a high standard of living. This chapter provides a snapshot of key environmental trends in Sweden over the period since 2000. It highlights some of the main environmental achievements and the remaining challenges on the path towards green growth and sustainable development. The chapter describes Sweden's progress in using energy and natural resources efficiently; in reducing the carbon intensity of its economy; in managing its natural asset base; and in improving its people's environmental quality of life.

1. Introduction

This chapter provides a snapshot of key environmental trends in Sweden. It highlights some of the main environmental achievements and the remaining challenges on the path towards green growth and sustainable development, focusing on the period since 2000. Drawing on indicators from national and international sources, it broadly follows the OECD framework for monitoring progress towards green growth (OECD, 2011). After a brief overview, the chapter describes Sweden's progress in using energy and natural resources efficiently, in managing its natural asset base and in improving its people's environmental quality of life. To the extent possible, it compares the state of the environment and key environmental trends with those of other OECD member countries and in relation to Sweden's national and international commitments. It therefore provides a baseline for subsequent chapters that assess the effectiveness of Sweden's environmental policies in influencing these trends and in using environmental objectives to generate economic opportunities.

Sweden has a sound, export-oriented economy, which is built on rich reserves of timber, iron ore and hydropower, as well as on a highly skilled labour force and significant investments in innovation. It has a strong industrial base, including production of iron and steel, wood, pulp and paper products, processed food, motor vehicles and high-tech equipment. Since 2000, Sweden's economic performance has been robust, better than the OECD average. Healthy public finances and structural reforms have limited the country's exposure to the 2008/09 crisis. With high per capita income, low inequality rates and good environmental quality, Swedish citizens enjoy a high standard of living (Box 1.1 and Figure 1.1).

The carbon intensity of the Swedish economy, in decline since 2000, is the second lowest among OECD member countries. This reflects the high share of renewables and nuclear energy in energy supply and electricity generation. The energy intensity of the economy has also decreased. Industry and transport are the largest consumers of energy and major sources of greenhouse gas (GHG) emissions. Between 2000 and 2012, GHG emissions decreased by 16%. Sweden has more than achieved both its commitment under the Kyoto Protocol and its more stringent national target (Section 2.1).

Sweden generates less economic wealth per unit of material used than the OECD average. It has, however, made progress in improving the material productivity of its economy. This result is due in part to an effective waste management policy that has led to high and growing rates of material recycling, composting and waste-to-energy recovery. In 2012, less than 1% of municipal waste was disposed of in landfills. While municipal waste generated per capita remains below the average level in the OECD, overall generation of municipal waste grew by 16% in 2000-12. Some decoupling from private final consumption was achieved in the aftermath of the economic downturn (Section 2.2).

More than two-thirds of Sweden's territory is flat and covered by forests. Almost all forest land is used for forestry, which plays a crucial role in Sweden's economy. While more

Box 1.1. **The economic and social context**

The economy

- Sweden's economy has grown faster than the OECD average. The annual growth rate was 1.5% between 2006 and 2011, compared to 0.8% in the OECD (OECD, 2012a). The economy faced a severe drop in 2009, with real gross domestic product (GDP) decreasing by 5% in just one year. It rebounded in 2010, but has been weakening since 2012, with annual growth reaching 0.7% in 2013 (OECD, 2013a).
- The population enjoys relatively high living standards, with a GDP per capita among the top 10 in OECD (Annex I.A). In 2013, GDP per capita was about USD 43 834 (in current prices and purchasing power parity).
- Sweden has a strong industrial base. Industry accounts for about 26.5% of GDP, above the OECD average of about 24%. Services account for around 72% of GDP, while agriculture represents nearly 2%.
- The environmental goods and services sector grew faster than the whole Swedish economy over 2003-11. In 2011, it is estimated the sector generated between 2% and 7% of GDP, 2.2% of total exports and 1.3% of total employment (Chapter 3).
- The maritime sectors (including shipping, fishing, coastal industry and tourism) represented 5.2% of private sector turnover and 4.5% of employment in 2009. They exert pressures on the marine environment, while benefiting from healthy marine ecosystem services (Chapter 5).
- Forestry plays an important role in Sweden's economy. In 2011, forestry products accounted for 7.4% of national exports, a share second only to Finland (OECD, 2013b).
- International trade plays a significant role in the economy. In 2012, exports in Sweden amounted to some 49% of GDP, while imports represented about 43%, above the OECD averages of about 29% for both exports and imports (Annex I.A). The country's major trading partners are Germany, Norway, UK and Denmark.
- The unemployment rate was 8% in 2012, in line with the OECD average (Annex I.B). The employment rate was about 74% in 2012, with a discrepancy between men and women of almost 4% in favour of the former.
- Both income inequality (as measured by the Gini coefficient) and relative poverty are low compared to many other OECD member countries (Annex I.B). However, income dispersion and relative poverty have risen over the past decade (OECD, 2012a).

Public finance

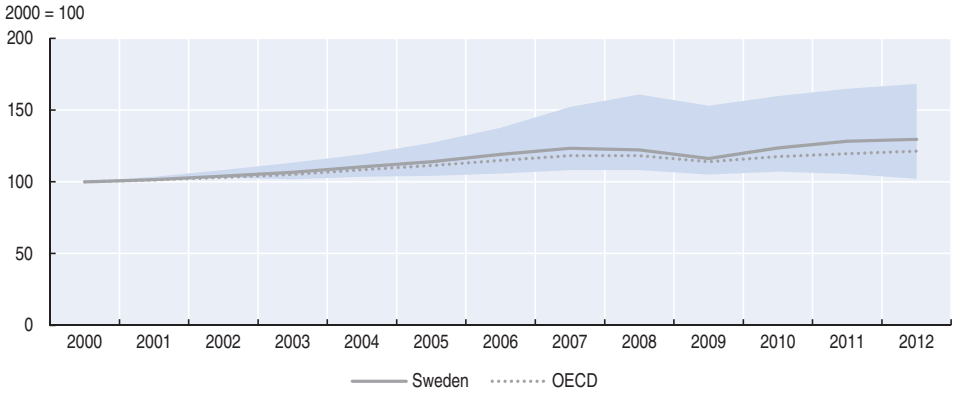
- Sweden enjoys a strong fiscal position. The fiscal balance worsened during the economic crisis to a deficit of 1% of GDP, but was much less than the 8.5% average deficit among OECD member countries. The public deficit is projected to increase slightly in 2014 to allow for economic stimulus. Public debt has gradually decreased since 2000, dropping from 64% of GDP to 52% in 2012 (OECD, 2013a).
- General government spending has by and large been high in the last decade, accounting for about 52% of GDP in 2012. In 2011, environment protection accounted for some 0.7% of total general government expenditure, slightly declining since the mid-2000s (Chapter 3).
- Swedish taxation levels are among the highest in the OECD. In 2012, the tax-to-GDP ratio stood at 44.3%, compared to the OECD average of 34.1%. The Swedish tax system relies on direct taxation of individual and corporate income more than the average tax system of other EU countries (Chapter 3).
- Environmentally related taxes accounted for 2.5% of GDP and 5.7% of total tax revenue in 2012, compared with the OECD Europe averages of 2.5% and 6.4%, respectively. They consist mostly of energy taxes.

Box 1.1. **The economic and social context** *(cont.)*

The population

- In 2013, the population in Sweden was more than 9.5 million. Population density is 21 inhabitants per square kilometre, significantly lower than the OECD Europe average of about 109.
- About 22% of the population lives in urban regions, which occupy less than 2% of Sweden's area; more than 90% of the country's area is classified as rural and is home to 48% of the population.
- Life expectancy at birth has further improved to 81.9 years in 2012, putting Sweden in the top 10 of OECD member countries. The total fertility rate accounted for 1.9 children per woman.
- Sweden's population is ageing: the share of people aged 65 and over reached 19% in 2012, above the OECD average of 15%. Conversely, youth population (under the age of 15) represents about 17% of the total, compared to an OECD average of 19%.
- The population is generally well educated: 87% of the working-age population (25-64 year-olds) has at least upper secondary education, among the highest rates in the OECD (Annex I.B). The share of tertiary graduates within the same age group (35.2%) is also above the OECD average (31.5%).

Figure 1.1. **Economic growth in Sweden and the OECD in 2000-12**



Note: The shaded area represents the range between the highest and lowest GDP growth rates among OECD countries. GDP at 2005 prices and purchasing power parities.
Source: OECD (2013), *OECD Economic Outlook No. 93* (database).

StatLink http://dx.doi.org/10.1787/888933144972

than 60% of forest area is certified, the intensity of forest resource use is among the highest in the OECD; a large number of forest species are endangered. Protected natural areas have been expanded since 2000. About 14% of land area and freshwaters, 5% of forest areas, and 6% of marine waters are under some form of nature protection. Further efforts are, however, necessary to achieve the Aichi targets on protected areas and other area-based biodiversity conservation measures. The conservation status of habitats and species listed in the EU Habitats Directive is relatively unfavourable (Section 3.1).

Due to abundant water resources and a relatively small population, Sweden has one of the lowest intensities of water use in the OECD. Groundwater quality is generally very good

and the quality of the majority of bathing waters is excellent. However, intensive use of hydropower has exerted ecological pressure on rivers and lakes. Half of surface water bodies have a moderate ecological status and 16% a poor or bad ecological status (Section 3.2). Several freshwater bodies and most marine ecosystems suffer from eutrophication. High loads of nitrogen from agriculture, wastewater, industry and shipping are a major cause of eutrophication of the Baltic Sea (Chapter 5). Nitrogen surplus per hectare of agricultural land is lower than in many other Nordic and Baltic countries; it has further declined, in part due to fewer livestock and less fertiliser use. Still, the amount of nitrogen fertiliser used per square kilometre of agricultural land is higher than the OECD average (Section 2.2).

Sweden's people assign higher importance to environmental protection than the European population on average. They also appear to be more satisfied with environmental quality. The burden of disease attributable to the environment is among the lowest in Europe. The share of the burden of disease associated with water and sanitation corresponds to the world's lowest rate, thanks to the large share of the population connected to high standard wastewater treatment plants. Although emissions of major air pollutants have fallen significantly, air concentration of particulates is often higher than accepted health standards in some parts of a few cities. Transport, other mobile sources and small-scale wood burning are major sources of emissions of nitrogen oxides and particulates. Emissions of heavy metals such as lead and mercury have also fallen significantly since 2000, but their level is still considered of concern, partly due to trans-boundary emissions. The potential exposure of people to persistent organic pollutants through contaminated fish constitutes a major hazard to human health (Section 4).

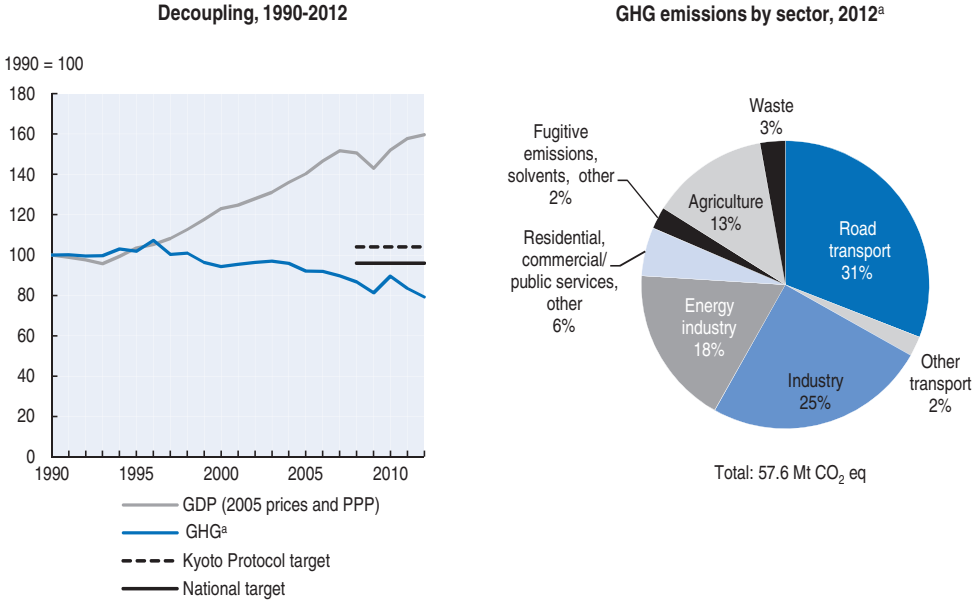
2. Transition to a low-carbon, energy- and resource-efficient economy

2.1. Carbon and energy intensities

Greenhouse gas emissions

- Total GHG emissions in 2012, excluding emissions and removals from land use, land-use change and forestry (LULUCF), totalled 57.6 million tonnes of carbon dioxide equivalent (CO_2 eq), with some 40 million tonnes coming from sectors outside the EU emission trading system. Average domestic emissions over the 2008-12 period were 15% below 1990 levels, meaning that Sweden went significantly beyond its Kyoto Protocol commitment of limiting GHG emissions to 104% of the 1990 base year emissions (Figure 1.2).
- Over 2000-12, total GHG emissions decreased by 16%, while overall GDP growth was around 30%. Hence, Sweden achieved a significant absolute decoupling of emissions from economic growth (Figure 1.2). Contributing factors include the overall decrease in emissions from energy use in the industrial, transport, residential and commercial sectors.
- Road transport and industry are the main sources of GHG emissions, accounting respectively for 31% and 25% of total emissions. Since 2000, almost all sectors decreased their emission levels. Emissions from energy industries, however, increased by 15%, and those from the use of commercial vehicles and buses increased by 22%.
- Sweden's CO_2 intensity (the ratio of CO_2 emissions from fuel combustion over GDP) has decreased by more than 30% since 2000, making it the second lowest among OECD member countries (Annex I.C). This mainly reflects the low-carbon energy mix, with a high share of renewables and nuclear power (Chapter 5).

Figure 1.2. **Greenhouse gas emissions: trend and sectoral breakdown**



a) Excluding emissions/removals from land use, land-use change and forestry.
Source: OECD (2013), *OECD Economic Outlook No. 93* (database); SEPA (2014), *National Inventory Report 2014* and "Sa-mar-miljon - Fakta & statistik" [State of the Environment - Statistics & Facts], website.

StatLink http://dx.doi.org/10.1787/888933144985

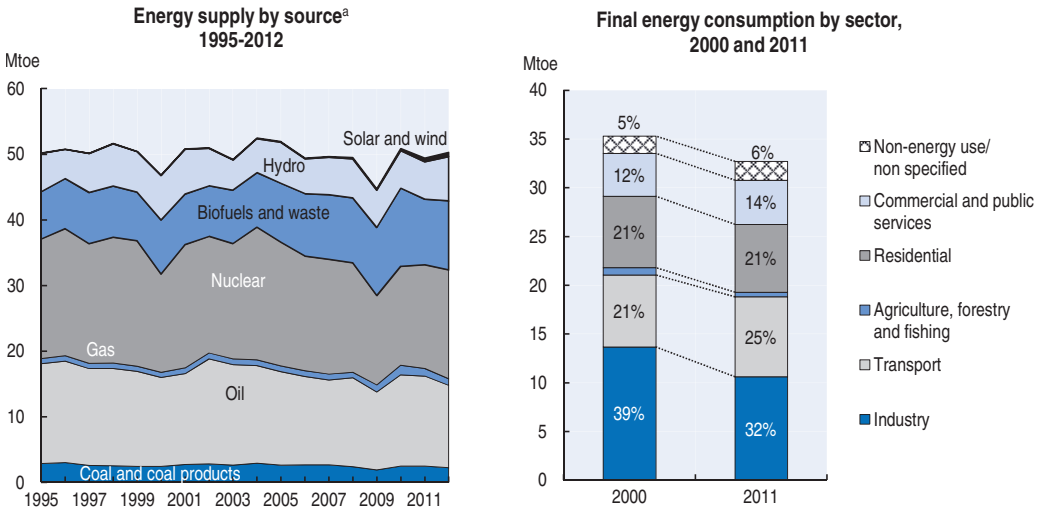
Energy intensity

- Total primary energy supply (TPES) in Sweden declined sharply in 2009 due to the economic downturn, but rose again with the recovery. Overall, it increased only by 2.8% between 2000 and 2012, while the economy grew by 30%. This trend is mostly due to energy efficiency improvements in addition to structural changes such as the replacement of oil by growing electricity use, heat pumps and combined heat and power.
- As a result, the energy intensity of Sweden's economy (measured as the amount of primary energy used per unit of GDP) has decreased by 21% since 2000. Sweden's energy intensity is in line with the OECD average, but higher than that of many other European countries (Annex I.A), due to the country's heavy industrial base and high heating needs.
- Total final energy consumption (TFC) in Sweden decreased by about 7% over 2000-11, mainly due to declining consumption in industry and to energy efficiency gains in other end-use sectors (Figure 1.3). Carbon and energy taxes helped stimulate energy efficiency improvements (Chapter 4).
- Industry is the largest energy user in Sweden, accounting for around 32% of TFC in 2011, followed by the transport and residential sectors (Figure 1.3). Consumption in the residential, commercial and public sectors has increased in the second half of the 2000s, and consumption in the transport sector has grown by 11% since 2000. Nonetheless, fuel switching, greater use of district heating and uptake of lower-emission vehicles have helped mitigate GHG emissions from buildings and transport (Chapter 4).

Energy mix

- Sweden has a very low share of fossil fuels in its energy mix compared to most other OECD member countries (Annex I.A). Oil, coal and natural gas accounted together for

Figure 1.3. **Energy supply and consumption**



a) Total primary energy supply. Breakdown excludes trade of electricity and heat.
Source: IEA (2013), *IEA World Energy Statistics and Balances* (database).

StatLink http://dx.doi.org/10.1787/888933144999

31% of TPES in 2012. Renewable sources and nuclear energy account for most of TPES (Figures 1.3 and 4.8). As a result, the carbon intensity of energy supply is very low by international comparison.

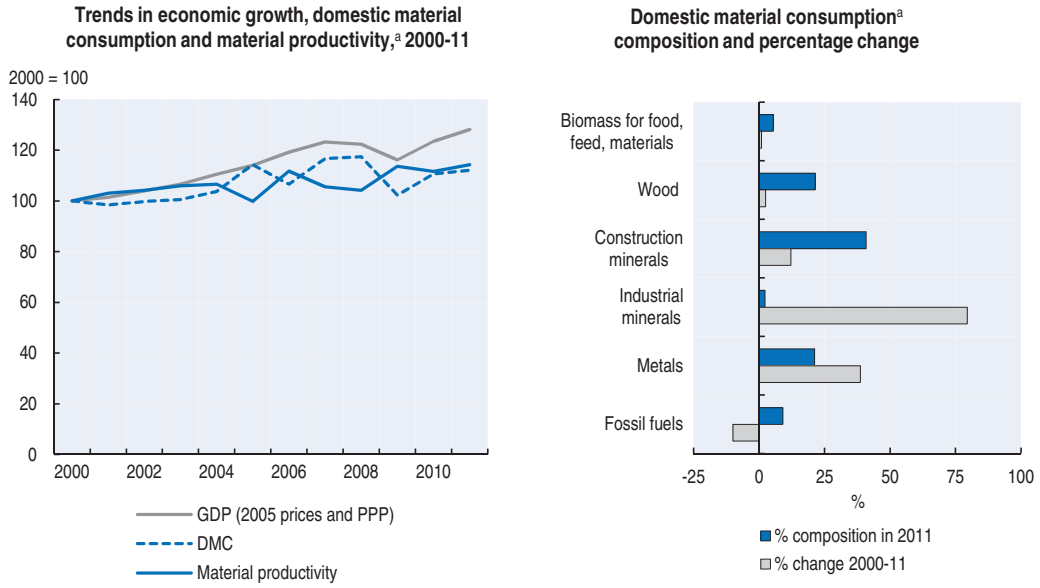
- Energy supply from renewable sources reached over 35% of TPES in 2012, the fourth highest share among OECD member countries (Annex I.A). Renewable energy supply has increased by 18% since 2000, mainly as a result of the growing electricity generation from wind and use of biofuels and waste (Figure 1.3).
- Biofuels and waste are the main sources of renewable energy (58%). Hydropower is the second largest renewable source and accounts for the vast majority of electricity generated from renewables.
- Sweden has surpassed its target of 49% renewables set under the Renewable Energy Directive (2009/28/EC), by reaching 51% of gross final energy consumption sourced by renewables in 2012. The favourable resource base (including hydropower potential and forests), along with policy measures such as the electricity certificate system and the carbon tax, are among the factors underlying this performance (Chapter 4).

2.2. Resource efficiency

Material productivity

- Sweden is 100% dependent on imports of fossil fuels for domestic consumption and exports of refined products; the country has no indigenous production of oil, natural gas and coal, but produces peat, mainly for electricity generation to complement biofuels. Sweden has large iron ore and uranium resources, even though the latter is widely imported due to the high costs of production (IEA, 2013).
- Between 2000 and 2011, the material productivity of Sweden, defined as the amount of economic wealth generated per unit of material used, grew by 14% (Figure 1.4). However, it is lower than the OECD average (Annex I.C).

Figure 1.4. **Resource productivity and material consumption**



a) Domestic material consumption (DMC) is the sum of domestic raw material extraction used by an economy and its physical trade balance (imports minus exports of raw materials and manufactured products). Material productivity designates the amount of GDP generated per unit of materials used. It refers to the ratio of GDP to domestic material consumption. A rise in material productivity is equivalent to a decline in material intensity (i.e. DMC/GDP).

Source: OECD (2014), *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933145004

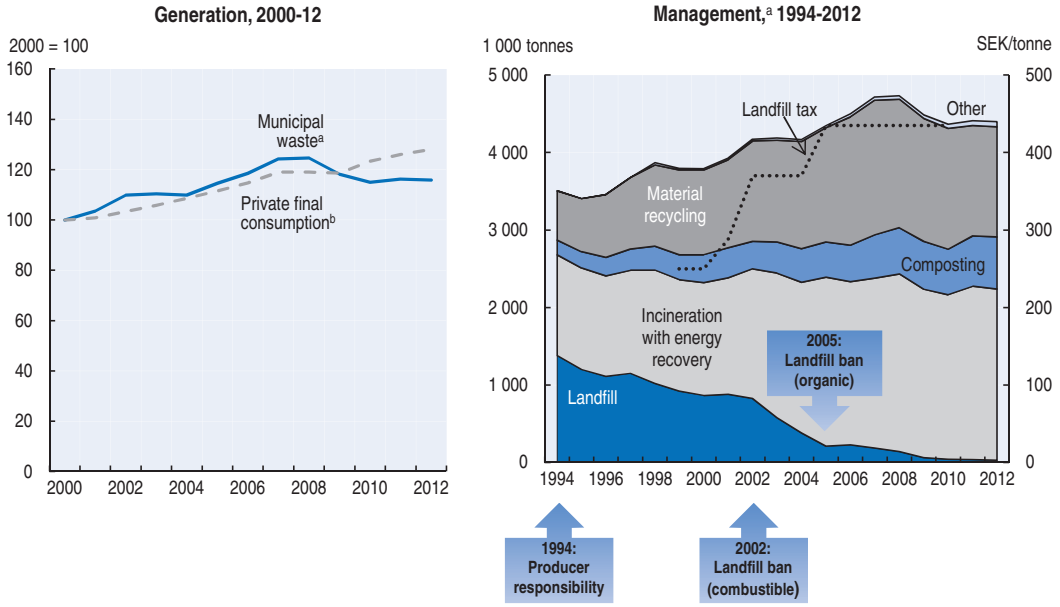
- Since 2000, Sweden has shown significant decoupling of domestic material consumption (DMC)[1] from GDP, the latter growing by about 30% between 2000 and 2011 compared to a 12% overall increase of DMC. Consumption of industrial minerals grew by nearly 80%, although they account for a minor share of total DMC. Construction minerals account for the largest share of DMC (about 40%), followed by wood and metals (about 20% each).

Waste generation and recovery

- With over 116 million tonnes of primary waste generated in 2010, Sweden was the 9th largest producer of waste in OECD Europe, while ranking as the 14th largest European economy in the OECD. The mining and excavation sector was responsible for the largest share, accounting for 77% of total waste; construction and manufacturing sectors accounted for a further 7-8% respectively. Hazardous waste represented only 2%.
- Generation of municipal waste increased by 16% over 2000-12,[2] well above trends in OECD member countries. However, some decoupling from private final consumption was achieved, especially during and after the economic downturn, when waste volumes fell (Figure 1.5).
- Municipal waste generated per capita increased from 430 kg to 460 kg over 2000-11, but remains below the OECD average of 530 kg (Annex I.C).
- With the introduction of a landfill tax in 2000, and bans on landfilling for combustible and organic waste in 2002 and 2005, municipal waste disposed in landfills decreased by 97% over 2000-12; landfills accounted for less than 1% of total municipal waste treatment in 2012 (Figure 1.5; Chapter 3). Incineration with energy recovery is currently the main treatment method (50%).

- In 2011, Sweden had composting and material recycling rates of 15% and 32% respectively, a level in line with the EU average (Figure 1.5). Sweden has exceeded its national targets for recovery of wastepaper, packaging and scrap vehicles. It has also surpassed the EU target of 4 kg per capita for electrical and electronic waste recycling, reaching 16.5 kg per person.

Figure 1.5. **Generation and management of municipal waste**



a) Waste collected by or for municipalities, including household, bulky and commercial waste, and similar waste handled at the same facilities. Includes hazardous waste from households (i.e. impregnated wood and asbestos).
b) At constant 2005 prices.
Source: Avfall Sverige (2013), *Swedish Waste Management;* OECD (2014), *OECD Environment Statistics* (database).

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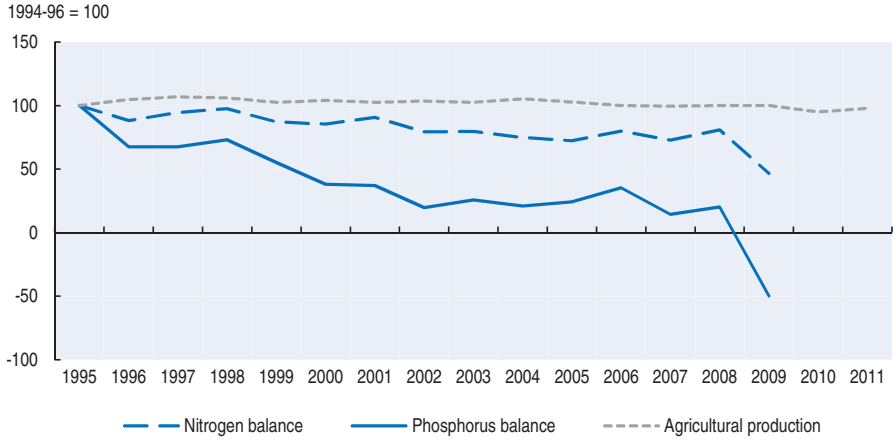
Nutrient balance and agricultural inputs

- Since 2000, agricultural production has remained quite stable, while nitrogen and phosphorus balances have dropped significantly (Figure 1.6). Nitrogen balance declined by 3.3% per year between 1998-2000 and 2007-09, compared to an OECD average of -1.4% (OECD, 2013c). One contributing factor was an increase in overgrown fallow land, which has contributed to reducing losses of both nitrogen and phosphorous.
- Nitrogen surplus per hectare of agricultural land has also declined; it was well below the OECD average in the late 2000s (OECD, 2013c) and lower than that of many other Nordic and Baltic countries. Fewer cattle farms (a 33% reduction between 2000 and 2010) and less fertiliser use helped reduce nitrogen and phosphorous inputs (SEPA, 2012a).
- Use of nitrogen and phosphorus fertilisers dropped by 8% and 38% respectively between 2002 and 2011. Yet the amount of nitrogen fertiliser used per square kilometre of agricultural land is higher than the OECD average (Annex I.C).
- Sweden is among the five OECD member countries with the lowest level of pesticide use per square kilometre of agricultural land. The quantity of pesticides sold decreased by 11% over 2000-10.

Figure 1.6. **Nutrient balances and agricultural production in 1995-2011**



Source: FAO (2014), *FAOSTAT* (database); OECD (2014), *Agriculture Statistics* (database); OECD calculations.

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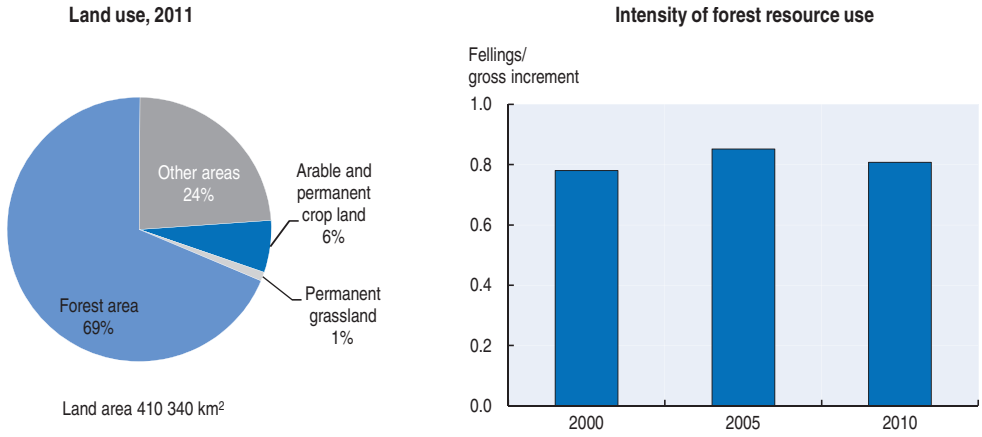
3. Managing the natural asset base

3.1. *Biodiversity and ecosystems*

Forests and agricultural land

- More than two-thirds of Sweden's territory is flat and covered by forests (Figure 1.7). The most common forest type in Sweden is pine, which covers 38% of productive forest area. Other forest types include spruce, mixed coniferous and deciduous forests. The growing stock in forest and other wooded land is among the lowest in OECD member countries (Annex I.C).[3]

Figure 1.7. **Land and forest use**



Source: FAO (2014), *FAOSTAT* (database); OECD (2014), *OECD Environment Statistics* (database).

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- Almost all forest land is used for forestry, 81% of which belongs to private owners and 19% to the state or other public owners (SFA, 2013). More than 60% of total forest area is

certified under the Forest Stewardship Council (FSC) system or the Programme for the Endorsement of Forest Certification (PEFC).

- Some 5% of forest land is protected as national parks, nature reserves, habitat protection areas or nature conservation agreements (SEPA, 2014a). Over one million hectares of forests are protected by the owners on a voluntary basis. However, in 2012, 340 000 ha of forests were set aside from forestry activities, below the target of 400 000 ha by 2010 (SEPA, 2014b).
- While intensity of forest use has decreased slightly in the second half of the 2000s (Figure 1.7), it remains the third highest in the OECD (OECD, 2013b). The 2012 in-depth evaluation of the environmental quality objectives (EQOs) acknowledged such intensive exploitation and considered the "Sustainable forests" objective difficult to be met by 2020 (SEPA, 2012b).
- According to the Swedish Red List, 861 forest species are endangered, among which are the western taigas, coniferous and certain types of hardwood forests. Major identified causes are fragmentation, increased density and insufficient quantities of dead wood. Behind this trend are issues like natural disturbances, climate change, and nitrogen deposits, as well as forest management and infrastructure development.
- Farmland accounts for some 6% of the country's land area (Figure 1.7). Farmland and grassland areas are in continuous decline, resulting in poor conservation status of species and habitats. Sweden considers that achieving its EQO "A varied agricultural landscape" by 2020 will require additional measures (SEPA, 2012b).
- Most pasture and meadowland is managed through agro-environmental aid within the rural development programme; since 2000, the economic support towards areas with high biodiversity and cultural value has increased (Chapter 3).

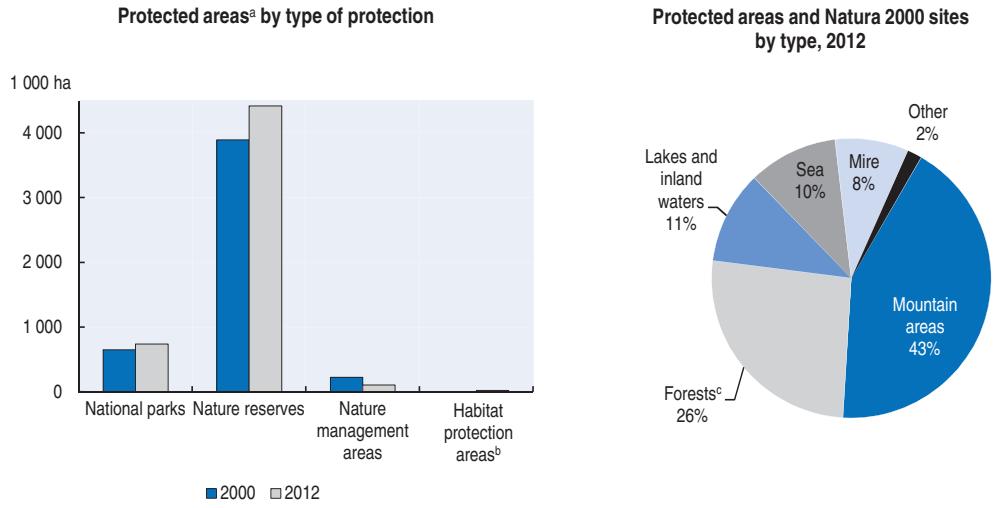
Protected areas

- More than six million hectares (about 14%) of Swedish land area and inland waters and 6% of marine waters are under some form of nature protection. Further efforts are necessary to achieve the 2020 Aichi biodiversity targets of establishing a system of protected areas and other area-based conservation measures covering at least 17% of terrestrial areas and inland waters and 10% of coastal and marine areas.
- Protected areas include a variety of designations, with natural reserves accounting for the largest category. The most common type of protected area and Natura 2000 site is mountain areas (43%), followed by forests (26%) (Figure 1.8).
- The number of protected areas increased by nearly 20 000 ha in 2012. National parks and natural reserves saw the biggest increase since 2000, growing by some 13% each.
- More than 50% of the population live close to protected areas, which are, on average, within 2.5 km of their residence and the majority of people can access them within 5 km.

Ecosystems and species

- The conservation status of some 60% of habitats and species listed in the EU Habitats Directive is unfavourable. Habitats particularly affected include dunes, grasslands and forests, while species most affected by group are reptiles, molluscs and arthropods (Figure 1.9).

Figure 1.8. **Natural protected areas in 2000 and 2012**



a) Nationally designated terrestrial protected areas according to the Swedish Environmental Code (Chapter 7).
b) Habitat protection areas in agriculture land (ÖBO) and forested land (SBO), reported as from 2011.
c) Including mountain birch and coniferous forests.
Source: Statistics Sweden (2013), "Environment", *Statistical Database.*

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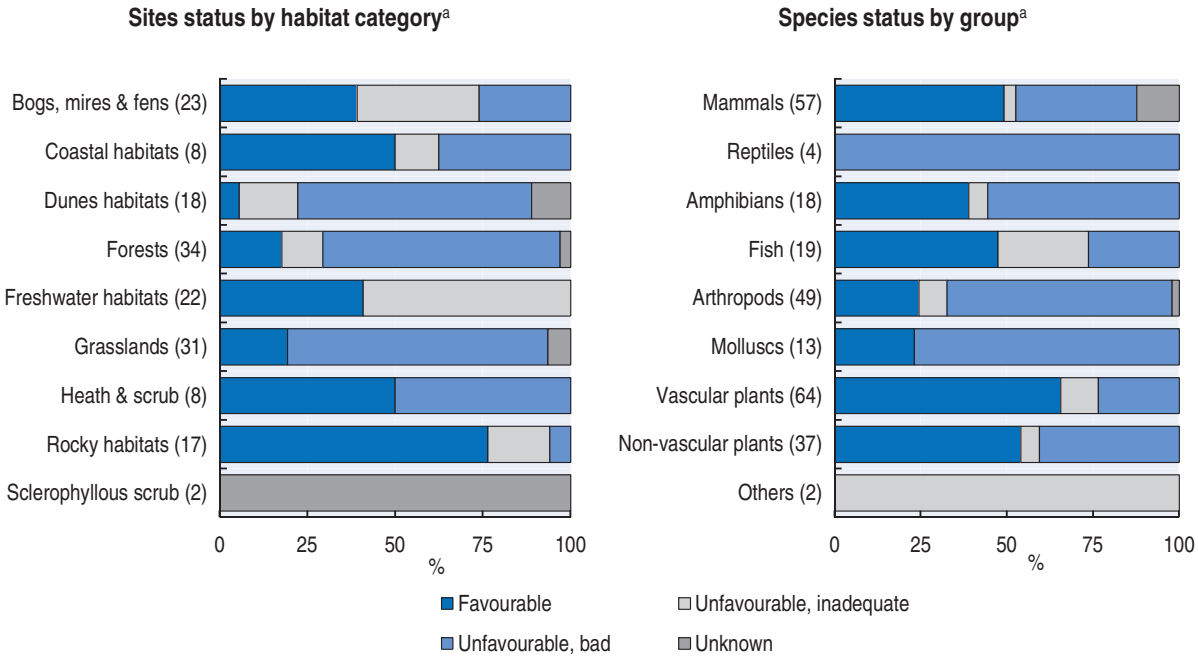
Figure 1.9. **Conservation status of sites and species of European Community importance in the 2000s**



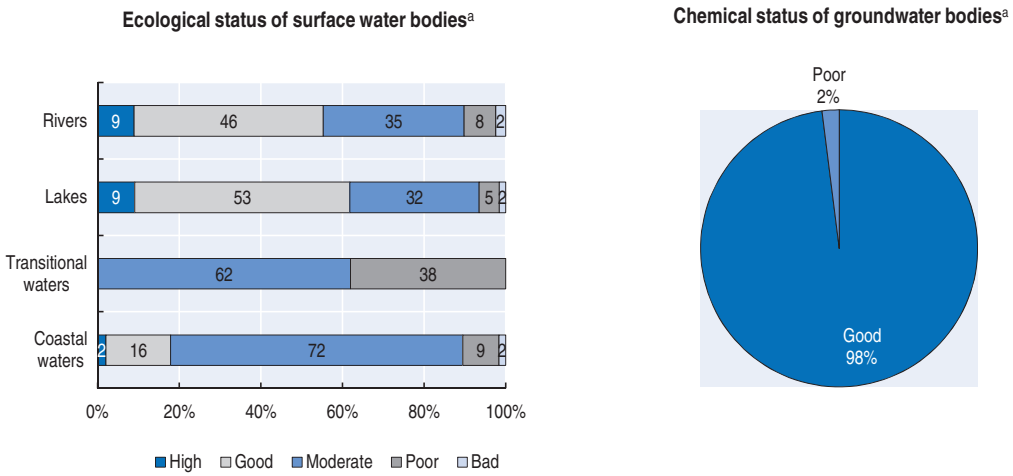
a) Data in brackets indicate the number of occurrences for each category/group.
Source: EIONET (2008), *Online report on Article 17 of the Habitats Directive: conservation status of habitats and species of Community interest (2001-2006).*

- The status of most marine ecosystems is not satisfactory due to eutrophication and overexploitation. High loads of nitrogen from agriculture, wastewater, industry and shipping are a major cause of eutrophication of the Baltic Sea (Chapter 5). Despite progress, as of 2010, Sweden was expected to miss its 2016 target of reducing nitrogen and phosphorous inputs into Baltic waters (Figure 5.8).
- Between 2005 and 2010, the number of red-listed wetland and freshwater species decreased. However, in 2010, several new species were put on the Swedish Red List of threatened species. At the same time, non-native species, mostly invasive, continue to increase.
- In Sweden, 20% of mammals species, 16% of birds species and 13% of freshwater and marine fish species are threatened, which is generally lower than in other OECD member countries. However, the share of vascular plant species that are threatened (nearly 16%) is comparatively high (Annex I.C).
- The situation of the seal species in Swedish waters has improved (Figure 5.6), but the state of the porpoise is of concern, especially in the Baltic Sea. Several stocks of local fish are critically decreasing, including haddock, Kattegat cod, herring and eels (Chapter 5). The cod stock has increased since 2005 in the Baltic Sea, but levels are still low compared to the 1980s (Figure 5.5).
- Overall, SEPA (2012b) indicated that reaching the EQOs "A balanced marine environment, flourishing coastal areas and archipelagos" and "A rich diversity of plant and animal life" is a major challenge.

3.2. Water resources

- Lakes cover close to 9% of Sweden's total area, ranging from clear, low-nutrient mountain lakes to high-nutrient lowland waters; wetlands account for about 12% of the land area and there are some 60 000 km of streams and rivers (OECD, 2004); the Baltic Sea is the world's largest brackish-water sea.
- With abundant water and a relatively low population, total abstraction is only 1% of total available freshwater resources in Sweden, among the lowest intensity of water use in the OECD (Annex I.C).
- Freshwater abstraction for public water supply has remained constant since 2000, but Sweden is among the 15 countries with the highest levels of abstraction for public supply per capita (OECD, 2013b). Industry accounts for the largest share of water demand (54%), followed by public water supply (34%), agriculture (4%) and electricity production (4%).
- Intensive use of hydropower and the presence of large channels have altered river morphology and hydrological conditions. Consequently, 8% of surface water bodies are considered to be heavily modified or artificial; all heavily modified water bodies present a "moderate ecological potential" and 85% of artificial water bodies have a "good ecological potential", according to the definitions of the EU Water Framework Directive (WFD) (European Commission, 2012).[4]
- Half of surface water bodies were classified as having moderate ecological status in 2009; 16% had poor or bad ecological status (Figure 1.10). Furthermore, 17% of inland surface water bodies are affected by acidification, 13 % by nutrients and 100% by mercury.
- Several freshwater bodies suffer from eutrophication resulting from a combination of factors that include nitrogen input from neighbouring countries (European Commission, 2012). It is

Figure 1.10. **Ecological and chemical status of water bodies in 2005-09**



a) As percentage of classified water bodies.
Source: EEA (2012), *European Waters - Assessment of Status and Pressures.*

unlikely that Sweden will meet its ambitious "Zero eutrophication" EQO by 2020, even if additional measures are taken (SEPA, 2012b).

- Groundwater quality is generally good; only about 2% is classified as having poor chemical status (Figure 1.10). For this reason, measures for tackling groundwater pollution remain at a general level, without being targeted to specific bodies (European Commission, 2012).
- Sweden accounts for about 2.1%, or 448, of reported bathing waters of the European Union. About 62% of coastal bathing waters and 74.5% of inland bathing waters had excellent quality in 2012, all above the EU average (EEA, 2012a).

4. Improving the environmental quality of life

4.1. *Environment and well-being*

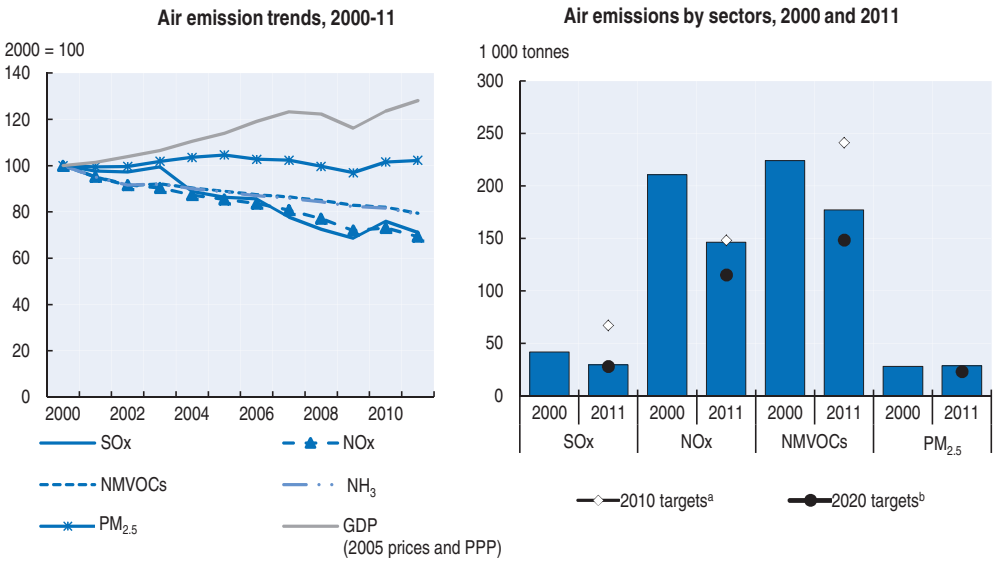
- In a 2011 survey, 83% of Swedish people responded that protecting the environment is very important to them personally; this represents the third highest score in the European Union (European Commission, 2011).
- Surpassing the OECD average of 84%, 95% of Swedish people say they are satisfied with water quality. This suggests Sweden has been successful in providing good quality water to its inhabitants (OECD, 2012b).
- Only 4% of people feel they lack access to green spaces or recreational areas, which is less than the 12% average of OECD European countries (OECD, 2012b).
- More than 20% of people are exposed to traffic noise in their living environment, which exceeds the national guideline level. The most frequently reported source of noise is road traffic.

4.2. *Air emissions and air quality*

- Emissions of all major air pollutants have declined since 2000, showing a decoupling from economic performance, especially in the second half of the decade. Emissions of

sulphur and nitrogen oxides (SO_x and NO_x) have decreased by about 30% and those of non-methane volatile organic compounds (NMVOCs) and ammonia by 21% (Figure 1.11).

Figure 1.11. **Air emissions**



a) Targets set by EU Directive 2001/81/EC (NEC Directive) on national emission ceilings for certain atmospheric pollutants.
b) National targets under the adapted Gothenburg Protocol.
Source: OECD (2014) *OECD Environment Statistics* (database); OECD (2013), *OECD Economic Outlook No. 93* (database).

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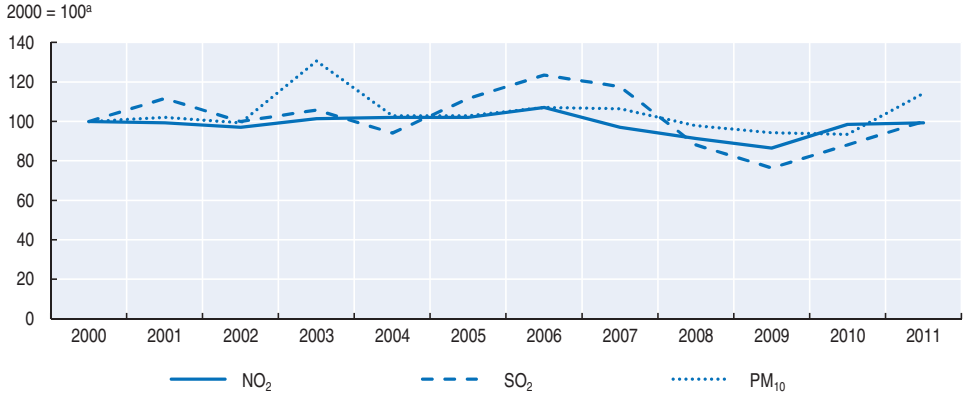
- Sweden's emissions of SO_x and NO_x per unit of GDP are among the lowest in the OECD (Annex I.C).
- Sweden has achieved all its emission ceilings under the EU National Emissions Ceilings (NEC) Directive. Achieving the 2020 national targets under the adapted Gothenburg Protocol will require maintaining the average annual rate of decrease of the 2000s (Figure 1.11).
- The main factors that have influenced trends since 2000 include the 2008/09 economic downturn that resulted in an overall reduction of emissions; implementation of EU air quality legislation; a tax increase on emissions of NO_x from combustion installations; replacement of diesel-fuelled generators for ships with electric generators; and stricter regulations for the use of studded tyres.
- Transport and other mobile sources are a major source of emissions of NO_x and small particles, largely due to the increased share of diesel cars, whose engines generate higher emissions of NO_x and particulate matter (PM).
- Between 2000 and 2011, total emissions of small particles increased: PM_{10} and $PM_{2.5}$ grew by 2% each. Major sources of these emissions, especially in urban areas, are road traffic and the burning of wood.
- Concentrations of NO_2, SO_2 and particulates in urban ambient air have hovered around the same level since 2000 (Figure 1.12). At national level, they have remained below the respective air quality limits (SEPA, 2014b). However, the PM_{10} daily limit value (50 $\mu g/m^3$) was exceeded in more than 12 Swedish cities (EEA, 2012b).

Figure 1.12. **Air quality in urban areas in 2000-11**



a) Index of relative changes in population-weighted averages of concentrations of selected air pollutants in a sample of 10-50 municipal areas during the coldest six months of the year 2000/01-2010/11.
Source: SEPA (2014), Environmental Quality Objectives Portal.

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4.3. *Water supply and sanitation*

- Sweden's local water supplies come equally from surface bodies and groundwater. About 85% of people obtain their drinking water from about 2 000 public, often municipally-owned water facilities. The remaining 15% have private water supplies, like wells and springs. An estimated 40 000 people using their own wells have drinking water that is unfit for consumption owing to high *E. coli* levels, while around 70 000 have drinking water that is fit for consumption but impaired (SEPA, 2010).
- The share of the population connected to urban wastewater treatment systems remained quite constant during the review period. It was 87% in 2011, among the 10 highest levels in OECD Europe (OECD, 2013b). All wastewater treatment plants provide secondary or tertiary treatment (Annex I.C).

4.4. *Health impacts*

- The latest assessment by the World Health Organization (WHO) indicates that the burden of disease attributable to environmental factors is 13%, down from 14% in the previous assessment. This is among the lowest levels in the European region (WHO, 2007; 2009).
- The share of the burden of disease associated with water sanitation and hygiene corresponds to the world's lowest rate. WHO estimates that 500 deaths per year can be attributed to outdoor air pollution (WHO, 2009).
- About 250 000 homes currently have levels of radon that exceed acceptable limits. Radon in housing gives rise to around 500 lung cancer cases each year. Of those affected, 90% are smokers (Swedish National Institute of Public Health, 2011).

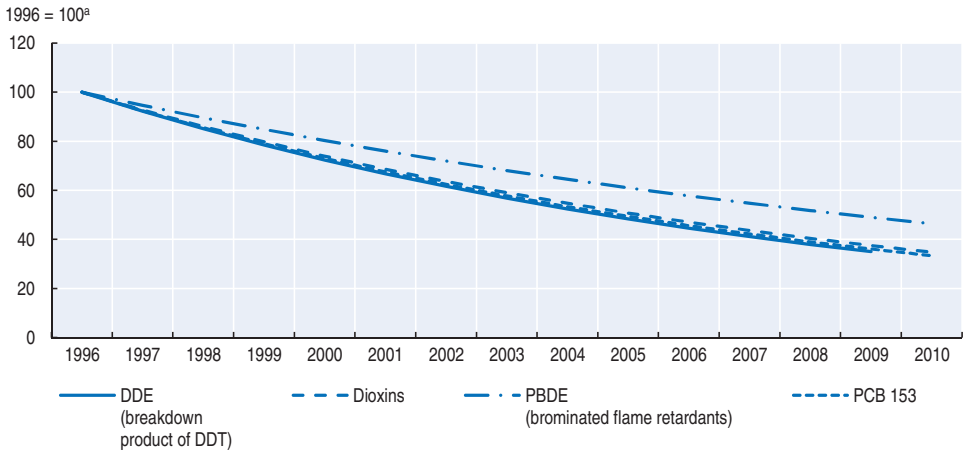
4.5. *Exposure to chemicals*

- Exposure to certain particularly hazardous chemicals is significantly lower today than in the past. At the same time, however, the population is exposed to many more chemicals because a larger number of products contain harmful substances. As the environmental

benefits of EU chemicals legislation will take time to emerge, SEPA (2012b) indicated that additional efforts will be required to achieve the EQO "A non-toxic environment" (Box 2.3).

- Emissions of persistent organic pollutants (POPs)[5] have decreased in the past two decades. However, levels of dioxins and polychlorinated biphenyls (PCBs) in fatty fish from the Baltic Sea are unacceptably high and constitute a risk to human health (SEPA, 2012c).
- Levels of POPs such as PCBs[6] and brominated flame retardants can be found in breast milk. Use of these pollutants has decreased in recent years due to stricter national laws and international agreements. This has resulted in declining concentration of POPs in breast milk, although at a lower rate than expected (Figure 1.13).

Figure 1.13. **Environmental toxins in breast milk in 1996-2010**



a) Index of relative changes in concentrations of certain persistent organic pollutants in breast milk of women having their first baby in the Uppsala region.
Source: SEPA (2014), Environmental Quality Objectives Portal.

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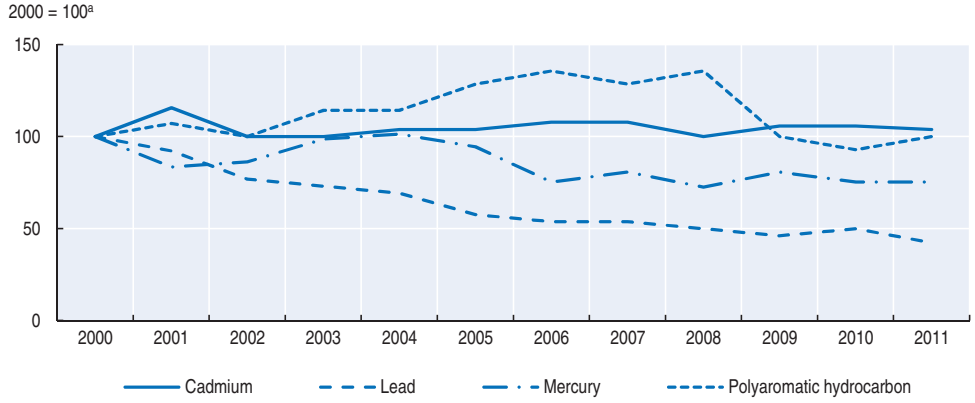
- Emissions of metals such as lead and mercury have diminished considerably since 2000 (by 58% and 25%, respectively), even though their level is still considered of concern, partly due to trans-boundary emissions.
- Since 2000, cadmium emissions have remained fairly stable. The exposure to cadmium is higher in Sweden than in other European countries; this can have negative repercussions on the functioning of kidneys and is a cause of osteoporosis.[7]
- Emissions of polycyclic aromatic hydrocarbons (PAH) grew significantly until 2008, but have fallen since then as a result of the recession and reduced industrial production. They have settled at 2000 levels (Figure 1.14).

Figure 1.14. **Heavy metals emissions in 2000-11**



a) Index of relative changes in national emissions of selected heavy metals.
Source: UNECE/EMEP (2013), *WebDab* (database).

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Notes

1. DMC is the sum of domestic extraction of raw materials used by the economy and their physical trade balance (imports minus exports of raw materials and manufactured products).
2. Generation of municipal waste includes hazardous waste from households (i.e. impregnated wood and asbestos).
3. The growing stock is the living component of the tree standing volume in an area of forest or wooded land.
4. The classification and assessment of heavily modified and artificial water bodies are incomplete (European Commission, 2012).
5. They include (non-exhaustive list): Polychlorinated biphenyls (PCBs) used in transformer oils, pesticides like DDT, endrin, dieldrin, aldrin, chlordane, toxaphene, heptachlor, mirex, hexachlorobenzene (HCB). However, existing monitoring programmes do not deal with all the substances covered by the convention. The substances covered by regular monitoring activities are PCBs, DDT, PCDD/PCDF and HCB (SEPA, 2012c).
6. PCBs – polychlorinated biphenyls – are synthetic (human-made) chemicals first produced in the late 1920s. They were used as cooling fluids in electrical equipment and machinery because of their durability and resistance to fire. They are currently banned.
7. In 2013, in accordance with EU legislation, Sweden notified its intention to reduce the permitted cadmium level in phosphorous fertilisers from 100 to 46 grams per tonne of phosphorous.

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PART I

Chapter 2

Policy-making environment

Sweden has created a system of ambitious environmental quality objectives, which underlies the country's environmental policies and engages all government agencies and administrative levels. This chapter analyses the Swedish environmental governance system, including mechanisms for horizontal and vertical co-ordination. It reviews the regulatory framework for environmental management, including for environmental impact assessment and permitting, as well as the enforcement and compliance assurance activities. The promotion of environmental democracy is also discussed.

Assessment and recommendations

Sweden has created a system of ambitious environmental quality objectives (EQOs), which underlies the country's environmental policies in every domain and engages all government agencies and administrative levels. The EQO system is unique and constitutes a major society-wide undertaking towards sustainable development. However, in its current form, it does not provide a platform for targeted, effective and efficient actions: it does not establish policy priorities commensurate with available resources or sufficiently mobilise different stakeholders. So far the government has not formulated a convincing policy response to the widely accepted conclusion that most of the EQOs will not be reached by the 2020 deadline.

Several elaborate horizontal and vertical institutional co-ordination mechanisms to implement environmental policy have been established within Sweden's relatively decentralised governance system. These include the Supervision and Regulation Council, as well as the nationwide Environmental Collaboration Sweden network and its regional equivalents, which provide civil servants at all administrative levels with guidance, information and training related to environmental law implementation. There is a growing trend for small communities to pool their resources and create inter-municipal environmental agencies. Nonetheless, despite these collaborative efforts, there is a lack of consistency and an uneven playing field across regions, and particularly across municipalities, in the application of environmental legislation. This is due to the institutional autonomy of the county and local governments, differences in their implementation capacity (e.g. in terms of resources and expertise) and the influence of local interests. The Environmental Protection Agency's statutory oversight of environmental performance of sub-national authorities is limited, and further constrained by the lack of routine compliance assurance data it receives.

Sweden has developed an effective system of integrated environmental permitting and notification, with differentiated requirements linked to the environmental risk of installations. The government has recently undertaken institutional changes to reduce the administrative burden of the permitting process (e.g. by shortening the permit-processing time) for the top two categories of environmentally hazardous installations. Environmental impact assessment for such installations forms an integral part of the permitting process.

Despite adoption of the new Planning and Building Act in 2011 with its expanded environmental provisions, there is still insufficient integration of environmental concerns into spatial planning. Municipalities use two main planning instruments: a long-term comprehensive plan (which describes the main features of the intended use of land and coastal zone areas) and a legally binding detailed development plan (which implements the comprehensive plan). Only about half of municipal comprehensive plans fully integrate national EQOs, and the quality of strategic environmental assessment (SEA) of detailed development plans varies across local authorities. Local interests continue to drive municipal planning decisions, often to the detriment of environmental protection.

Ensuring compliance with the Environmental Code is one of the government's clear priorities. However, the lack of a coherent compliance assurance strategy often compromises the effectiveness and efficiency of practical work by supervisory authorities at regional and local levels. Information tools and regulatory incentives are not used sufficiently to promote voluntary environmental compliance, particularly among small and medium-sized enterprises (SMEs). There is also a considerable enforcement gap because prosecutors pursue less than one-third of potentially criminal offences referred to them by supervisory authorities. Since those offences cannot be subject to administrative sanctions without risk of a double penalty, a significant share of violations go essentially unpunished, undermining the motivation and credibility of inspectors.

Sweden has made remarkable progress over the reporting period in the area of environmental democracy. It has ratified the Aarhus Convention, adopted important laws to guarantee public access to environmental information and implemented key tools to provide this information to the public (among others, through the creation of the environmental data portal). Sweden has also significantly expanded environmental access to justice by non-governmental organisations.

Recommendations

- Consider how the EQO system could be made a more effective strategic framework for environmental policy, including by distinguishing the EQOs that mainly require domestic efforts from those requiring international efforts; setting short- and medium-term priorities among EQOs; and clearly defining economically feasible measures, and allocating sufficient resources, to achieve these priorities within definite timeframes.
- Make further efforts to integrate environmental considerations and the achievement of EQOs into spatial plans; while respecting municipalities' prerogatives for spatial planning, establish national environmental minimum requirements or binding guidelines with respect to land use (including climate change resilience measures) and buildings; and strengthen the application of SEA to municipal spatial development plans.
- Strengthen the Environmental Protection Agency's oversight of supervisory activities conducted by regional and municipal authorities; and establish a performance measurement system with a uniform set of input, output and outcome indicators and data reporting procedures.
- Make further efforts to enhance the environmental performance of SMEs, including by creating a national web-based information support tool on compliance and green business practices, targeting sectors with a high composition of SMEs and the greatest potential risks to human health and the environment; introducing incentives to implement sound environmental management practices (e.g. reduced inspection frequency or permit fees); and issuing compliance promotion guidance to county administrative boards and municipalities.
- Strengthen the sanctions for non-compliance with the Environmental Code by further clarifying the boundary between administrative and criminal offences; applying appropriately high "sanction fines" to administrative offences; and continuing to develop an agreed procedure between prosecutors and enforcement authorities for investigating offences.

1. Environmental policy and institutional framework

1.1. *Institutional responsibilities for environmental management*

Although Sweden is a unitary state, it has a decentralised governance system with 21 counties and 290 municipalities. The municipalities have extensive autonomy in implementing national policies and legislation.[1] Higher-level authorities generally do not have the mandate to direct sub-national and local governments but rather employ a range of guidance and co-ordination mechanisms (Section 1.2) to ensure consistent policy implementation nationwide.

The Ministry of the Environment is a small policy-making authority that oversees the work of several agencies[2] with the following functions:

- The Swedish Environmental Protection Agency (SEPA) has overall responsibility for supporting, co-ordinating and overseeing the implementation of Sweden's environmental policy, including the development of policy instruments, as well as production and dissemination of information in the field of the environment.
- The Swedish Agency for Marine and Water Management (SwAM) has overall responsibility for marine and water environment issues. When the agency was established in 2011, the National Board of Fisheries was disbanded, and water- and marine-related environmental issues were transferred from SEPA to the new agency. Consolidating responsibility for water and sea management (including fisheries control) in one authority is intended to promote better integration of marine and water policies (Chapter 5).
- The Chemicals Agency works to prevent damage to people and the environment caused by chemical and biotechnological products.
- The Swedish Meteorological and Hydrological Institute (SMHI) provides climate- and water-dependent operations with background material for planning and decision making. The institute, which acts as a central government expert body on meteorology, hydrology and oceanography, is a resource in environmental work.
- The Swedish Radiation Safety Authority has been a managing authority under the Ministry of the Environment since 2008, with responsibility within the areas of radiation protection, nuclear safety and nuclear non-proliferation.
- The Board of the Swedish Nuclear Waste Fund administers funds set aside to finance current and future costs for dealing with spent nuclear fuel and other radioactive waste.

Other central government agencies with key environmental responsibilities are the National Board of Housing, Building and Planning (NBHBP) whose remit includes land-use management; the Swedish Energy Agency; the Geological Survey of Sweden; the Swedish Board of Agriculture; and the Swedish Forestry Agency.

At the regional level, county administrative boards (CABs) – central government agencies headed by appointed governors – have major environmental permitting, compliance monitoring and enforcement responsibilities; this is part of a broader mission to implement and clarify government policies across the counties. County councils – elected bodies in the counties – are in charge of designing and co-ordinating regional development strategies that cover some environmental issues.

In 2004, as part of the implementation of the European Union (EU) Water Framework Directive, Sweden was divided into five water districts based on the natural boundaries of watersheds. Each district has a regional water authority with a water delegation, an expert

body that elaborates river basin management plans and water quality standards. Five CABs have been appointed as water authorities. The water authorities and CABs within the respective water districts are working to form a water board within each drainage area to provide the natural forum for co-operation within the drainage area. The water boards are the regional and local forums where affected entities can meet and discuss common water issues. In June 2013, the number of water boards in Sweden totalled just over 125.

Local authorities are responsible for spatial planning, provision of public services (water supply, sanitation and municipal solid waste management) and environmental and health protection (including air quality issues). Municipal councils can issue ordinances in their areas of responsibility, while the local Environmental and Public Health Committees (EPHCs) enforce national laws and regulations.

Finally, important environmental functions reside in the judiciary. Five Land and Environment Courts were established in 2011. They are part of the district courts in Nacka, Vänersborg, Växjö, Umeå and Östersund. They merge the earlier property courts and environmental courts, among others, to streamline handling of cases that arise from applying the Planning and Building Act. These cases include review of local land-use plans and building permits, which had been previously considered by the government, administrative courts and property courts. The Land and Environment Courts also deal with permitting of environmentally hazardous activities and waterworks operations, environmental damage and compensation issues. The courts' permitting function constitutes a unique feature of the Swedish environmental management framework and allows for a balanced assessment of different economic interests and potential environmental impacts. The Land and Environment Court of Appeal is part of the Svea Court of Appeal.

1.2. Horizontal and vertical collaboration mechanisms

Governmental and non-governmental stakeholders at all administrative levels signal a lack of consistency and an uneven playing field across regions, and particularly across municipalities, in the implementation of environmental legislation (see also Section 3.2). The main factors contributing to this situation are an imbalance of technical skills and financial resources, the influence of different local interests and the constitutional independence of local authorities. The OECD had previously recommended that Sweden strengthen horizontal collaboration to better integrate environmental concerns into sectoral policies, improve co-operation on environmental matters between national, regional and local agencies, and strengthen guidance from the central government to regional and local authorities (OECD, 2004). More recently, the 2012 in-depth evaluation of regional environmental action by SEPA found an "implementation deficit" in many environmental policy areas, mainly due to limited resources and poor control from the central government. In particular, this evaluation signalled the need for more co-operation between CABs and central agencies, as well as for more support from the CABs to municipalities to integrate environmental objectives into regional and local activities.

To respond to these concerns, the Swedish government has encouraged the creation of different institutional mechanisms to bring together national, regional and local authorities with environmental responsibilities. Apart from the collaborative mechanisms related to the implementation of Environmental Quality Objectives (Section 1.3), special organisations such as the Swedish Supervision and Regulation Council, have been set up to deal with priorities related to implementing environmental law (Box 2.1).

Box 2.1. **Swedish Supervision and Regulation Council**

Parliament established the Swedish Supervision and Regulation Council to enable co-operation between Swedish public authorities on regulation and enforcement matters with respect to the implementation of the country's Environmental Code. The government appoints the council's members. A SEPA representative chairs the council, which also includes representatives of other national authorities (the Board of Agriculture, Chemicals Agency, Public Health Agency, and Surgeon General), Swedish Association of Local Authorities and Regions (SALAR), two CABs and one municipality.

The council organises its activities around time-limited projects with participation from various member authorities. Its secretariat regularly conducts seminars on topics of common interest for the member authorities such as inspection planning based on the environmental quality objectives, linkages between environmental management systems and compliance monitoring, enforcement methods, and the quality of enforcement. These seminars act as forums for discussing common viewpoints and promoting integration between different sectors and administrative levels.

A number of "vertical" networks oriented towards joint projects enable the collective development of solutions to common problems and the sharing of guidance development costs across a number of jurisdictions and agencies. Sweden regards these networks as key to addressing inconsistencies in the implementation of environmental policy across the country. Under the aegis of the Supervision and Regulation Council (Box 2.1), a Supervision Guidance Network facilitates online exchanges between civil servants working in central and regional environmental authorities.

Another good example is Environmental Collaboration Sweden (Miljösamverkan Sverige), a partnership created in 2005 at the initiative of the CABs. Currently, network members include all the CABs, SEPA, SwAM and the Swedish Board of Agriculture. It aims to ensure a more uniform handling of regulatory issues across the country by providing CABs with guidance, information, training courses, seminars, etc. To create more uniform regulatory guidance for local authorities, as well as to encourage co-operation across the regions, all CABs were required to harmonise their administrative guidance in 2009-12. The network employs a small staff to lead a number of project groups in different areas, comprising five to six officials from the CABs, as well as an occasional representative of a central authority. The CABs particularly appreciate this mechanism, especially for face-to-face interactions among peers.

This model has been replicated in 11 of 21 Swedish counties through regional environmental collaborations – a vehicle for sub-national-local co-operation between a CAB and the county's municipalities. Other CABs prefer to lead the co-ordination work themselves rather than set up an external mechanism for it. The collaboration is based on issue groups and projects (mostly to produce sector-specific guidance), similar to the national scheme. This work also supports CABs in their supervision of local authorities. In 1999, the county of Västra Götaland was the first to establish a regional environmental collaboration (long before the national mechanism was created), bringing together the CAB and 49 municipalities.

Small municipalities frequently lack the means to have a fully-fledged environmental regulation and supervision programme. As a result, they prefer to pool resources with

neighbouring communities to create inter-municipal environmental agencies. As part of a growing nationwide trend, about 30 joint local-level environmental authorities exist across Sweden, which explains why there are 256 EHPCs across 290 municipalities. Five municipalities in the area of Östra Skaraborg in the county of Västra Götaland, for example, share a staff of 30 environmental and health inspectors. There are even some cases of co-operation between neighbouring local authorities from different counties.

1.3. National environmental quality objectives and strategic sustainable development planning

Sweden's unique environmental quality objective (EQO) system, established in 1999, is sometimes referred to as the country's largest co-operative project. Parliament adopted 16 ambitious, but broadly formulated, EQOs (Box 2.2): the objective "A rich diversity of plant and animal life" was added in 2005 to the original 15 EQOs. They do not have a legal status, but provide long-term strategic orientation for Sweden's environmental policy.

In 2010, to better integrate the EQO system with the government's policy making, Parliament (Riksdag) approved a new target structure within this system, which now includes three tiers:

- A generational goal "to pass on to the next generation a society in which major environmental problems have been solved without increasing environmental and health problems beyond Sweden's borders". The generational goal is complemented by a list of seven cross-cutting values to be protected and the changes in society required to achieve the desired environmental quality.
- 16 EQOs that describe the desired state of the environment, with detailed, though in many cases still quite generally formulated, specifications for each objective (adopted by the government in 2012).
- Milestone targets that specify concrete actions towards achieving one or more EQOs (they replaced 72 EQO-specific interim targets in 2010) and are usually part of a respective strategy.

Also in 2010, the government appointed an All-Party Committee on Environmental Objectives (which replaced the EQO Council of stakeholder government agencies) to advise how the EQOs can be achieved and to propose strategies that would comprise milestone targets, policy instruments and measures in priority areas.[3] The government has adopted two strategies – for a non-toxic environment (Box 2.3) and for biodiversity and ecosystem services – on the basis of the committee's proposals. The All-Party Committee has so far developed strategies on hazardous substances (Box 2.3), sustainable land use and sustainable water policy, which the government has not yet adopted.

The EQO system engages government agencies at all administrative levels, with implementation responsibilities often residing at the sub-national level. Eight central government agencies have responsibility for monitoring and evaluating the implementation of one or more EQOs, and several others are expected to promote and report annually on progress towards the EQOs in their respective sectors. The regions and municipalities are expected to adapt the national EQOs to local conditions and priorities. According to a SALAR survey in 2011/12, 77% of municipalities have adopted environmental targets, based either on national EQOs or on local priorities, and have planned actions to achieve them. The number of municipalities with action plans or strategies based on the national EQOs has doubled since 2006. Overall, the EQO system has

Box 2.2. **Sweden's environmental quality objectives**

1. **Reduced climate impact:** Concentrations of greenhouse gases in the atmosphere must be stabilised at a level that will prevent dangerous anthropogenic interference with the climate system.
2. **Clean air:** Concentrations of air pollutants should not exceed low-risk levels for cancer or target values for protection against diseases or impacts on plants, animals, materials and cultural objects.
3. **Natural acidification only:** The acidifying effects of deposition and land use must not exceed the limits that can be tolerated by soil and water.
4. **A non-toxic environment:** Concentrations of non-naturally occurring substances should be close to zero, and their impacts on human health and ecosystems should be negligible.
5. **A protective ozone layer:** The ozone layer should be replenished so as to provide long-term protection against harmful ultraviolet radiation.
6. **A safe radiation environment:** Human health and biodiversity must be protected against the harmful effects of radiation.
7. **Zero eutrophication:** Nutrient levels in soil and water must not be such as to adversely affect human health, biodiversity or the possibility of varied use of land and water.
8. **Flourishing lakes and streams:** Lakes and watercourses must be ecologically sustainable, and their variety of habitats must be preserved.
9. **Good-quality groundwater:** Groundwater must provide a safe and sustainable supply of drinking water, and contribute to viable habitats for flora and fauna in lakes and watercourses.
10. **A balanced marine environment, flourishing coastal areas and archipelagos:** Coasts and archipelagos must have a high degree of biodiversity and represent a recreational, natural and cultural asset.
11. **Thriving wetlands:** The ecological and water-conserving functions of wetlands must be maintained.
12. **Sustainable forests:** The biodiversity, cultural heritage and recreational value of forests must be protected.
13. **A varied agricultural landscape:** The food production value, biodiversity and cultural heritage of agricultural land must be preserved.
14. **A magnificent mountain landscape:** The pristine character of the mountain environment must be largely preserved.
15. **A good built environment:** Built areas must provide a healthy living environment and be designed and located in accordance with sound environmental principles.
16. **A rich diversity of plant and animal life:** Species habitats and ecosystems, their functions and processes must be safeguarded.

Source: SEPA (2012), *Sweden's Environmental Objectives – An Introduction.*

helped mainstream the environment into policy making and improve multi-level environmental governance.

Despite these positive developments, Sweden faces significant challenges in reaching its EQOs. The latest in-depth evaluation in June 2012 (see also Section 1.4) found that 14 of the 16 EQOs would not be reached by the target year 2020 because the respective policy

Box 2.3. **Strategy for a non-toxic environment**

In November 2013, the government presented a strategy for a non-toxic environment in the bill "Towards a toxic-free everyday environment: A platform for chemicals policy". The strategy contains eight milestone targets for dangerous substances that were previously established by the government, as well as measures necessary to reach the milestone targets and the EQO "A non-toxic environment".

The eight milestone targets cover:

- particularly dangerous substances
- knowledge of the health and environmental profiles of chemical substances
- information about dangerous substances in products
- development and application of the EU's chemical rules
- more effective supervision of chemicals across the EU
- non-toxic and resource-efficient ecocycles
- reducing children's exposure to dangerous chemicals
- expanding the environmental aspects of pharmaceuticals legislation in the EU and globally.

The strategy focuses on the implementation and strengthening of the existing EU regulatory framework for chemicals in order to generate new knowledge and to put measures into action, and to better protect human health and the environment. The government's commitment to a plan of action for non-toxic living is an important part of the strategy.

Source: Government Offices of Sweden, "Towards a toxic-free everyday environment: A platform for chemicals policy", Government Bill (2013/14:39).

instruments introduced to date appear to be insufficient. The only ones that will be achieved are "A protective ozone layer" (due to implementation of the Montreal Protocol on eliminating ozone-depleting substances) and "A safe radiation environment".

The attainment of some EQOs largely depends on international efforts in the respective areas, and Swedish policy makers acknowledge that national policies will not be enough. An additional problem is the lack of feasibility evaluation, including cost-benefit analysis, going into the setting of EQOs and deadlines for reaching them.

Institutional challenges also represent a key impediment to reaching the EQOs. In a 2013 report, the Swedish Agency for Public Management (Statskontoret) concluded that EQO-related responsibilities are often unclear to the national agencies involved and generally have little influence on their routine environmental work. At the regional and local levels, lack of resources is seen as the main obstacle to implementing the national EQOs. So far the government has not formulated a convincing policy response to the conclusions of the 2012 evaluation and the underlying problems.

In addition to the EQO system, Sweden developed several other sustainable development policy documents over the last decade: a Strategy for Sustainable Development was published in 2004, followed by "Strategic challenges – A further elaboration of the Swedish Strategy for Sustainable Development" in 2006. These documents responded to the EU-wide Strategy for Sustainable Development, identifying government priorities and challenges, as well as sustainable development indicators. However, they were regarded as redundant to the EQO system and were eventually abandoned.

1.4. Performance measurement

Over the last decade, Sweden has made significant progress in developing and improving its system of environmental indicators in line with a recommendation of the 2004 *OECD Environmental Performance Review of Sweden*.

In collaboration with other government agencies and CABs, SEPA monitors the implementation of the EQOs through the organisation of Regional Development and Co-operation in the Environmental Objectives System (RUS), which operates under a mandate from, and in close contact with, the CABs. The prospects for achieving the EQOs are assessed each year to inform the annual budget bill; an in-depth evaluation is undertaken every four years (the last one was done in 2012, as discussed in Section 1.3).

The authority responsible for each EQO devised national and regional EQO indicators. Currently there are 112 such indicators, ranging from pollution releases and ambient environmental quality to biodiversity measures, environmental health and safety, recycling rates and land-use changes. RUS has the primary responsibility to collect data on the joint regional indicators and maintain them on the environmental objectives portal. In addition, the Ministry of the Environment has given Statistics Sweden the task of assessing the country's progress towards sustainability with the help of the EU sustainability indicators compiled by Eurostat.

However, given the institutional autonomy of the county and local authorities, the upper-level authority's oversight of their performance in environmental policy and law implementation is a challenging task. So far, such oversight has been limited to ad hoc performance reviews that usually focus on specific issues and rely on questionnaires and interviews. Since 2011, SEPA has issued annual reports on compliance monitoring (supervision) to present an overall assessment of environmental compliance assurance across the country. Similarly, CABs, using their right to ask for data from local authorities, conduct occasional questionnaire-based reviews of municipal EPHCs. Their focus is typically more on the organisational management of the inspection process than on its results.

The lack of routine compliance data reporting (discussed further in Section 2.3) is another key obstacle to the establishment of systematic vertical oversight. An inter-agency dialogue is currently exploring how to standardise and collect this information from the competent county and local authorities.

2. Environmental requirements

2.1. Environmental standards and transposition of EU directives

In keeping with the 1998 Environmental Code – the core piece of Sweden's environmental legislation – the government issues environmental quality standards, as well as environment-related general binding rules through ordinances. Most such norms directly apply respective EU directives. Over the last 10 years, Sweden transposed into its legislation key pieces of the EU environmental *acquis*, including the framework directives related to air quality (2008/50/EC), water (WFD, 2000/60/EC), waste (2008/98/EC), industrial emissions (IED, 2010/75/EC) and marine strategy (2008/56/EC). However, the European Commission has pursued a number of infringement cases against Sweden. Recent cases included Sweden's failure to fully transpose the Waste Electrical and Electronic Equipment Directive (2002/96/EC) into national legislation and for having several large industrial installations without new or renewed IED permits (European Commission, 2012). As of

early 2014, Sweden had 13 pending infringement cases related to environmental legislation, compared to the EU average of 11 environmental infringement cases per country.

The regulatory agencies' proposals for new and amended legislation must be subject to regulatory impact assessment (RIA), which was strengthened by a 2007 ordinance. The environmental component of RIA uses methodology developed by SEPA. The Swedish Better Regulation Council, an advisory body appointed in 2008, also reviews all regulatory proposals for their potential administrative burden on businesses, and recommends ways to reduce such burdens. However, cost-benefit analysis of new regulatory measures is not used systematically, which is linked to the lack of economists in key environmental agencies.

2.2. Environmental impact assessment and permitting

Installations are classified into three categories, depending on their level of risk to the environment and human health. Large industrial installations (the A list) are required to obtain an integrated permit from one of the Land and Environment Courts. Smaller, but still hazardous installations (B-activities) get their integrated permits from the environmental assessment delegations (EADs) at the CABs, which are separate from the division performing inspection functions.[4] Operators of all permitted installations are required to use best available techniques, conduct self-monitoring of their impacts and submit annual reports to the competent supervisory authority.

The business sector has long been calling for shorter processing times at the EADs: at the time of the previous review, the average permit processing period was 18-24 months for larger installations. The establishment of Land and Environment Courts in 2011 simplified and rationalised the permitting process. In June 2012, it was decided to concentrate the processing of permit applications from B-activities in 12 of 21 CABs to simplify assessments and reduce processing to under six months.

Facilities with limited impact or causing only local disturbances (the C list) are not subject to permitting, but operators must notify their local authority's EPHC, which may decide on mitigation measures or prohibit the activity. In addition, U-class facilities (such as petrol stations and dry cleaners) are not required to notify environmental authorities but are registered with, and sometimes approached by, municipal EPHCs; this occurs mostly to promote good environmental behaviour corresponding to their general "duty of care" obligations. Municipalities complain that very little guidance is available nationally or at the county level on how to deal with U-class installations.

For installations subject to permitting, the operator must prepare an environmental impact assessment (EIA) report statement and submit it with the permit application; EIA reports are available to the public. Besides activities subject to permitting, the Environmental Code requires an EIA for water operations, quarrying operations and game enclosures. In other cases, the CAB decides whether the proposed activity will likely have a significant environmental impact and thus require an EIA. It bases its screening decisions on the proponent's information (provided during the "early consultation" phase) on the nature, extent and location of the proposed activity.

Apart from the Environmental Code, EIA requirements are contained in the Civil Aviation Act, the Roads Act, the Certain Pipelines Act, the Certain Peat Deposits Act, the Minerals Act, the Construction of Railways Act and the Electricity Act. No single authority

is responsible for EIAs; the authority that processes an application for a project requiring an EIA should declare whether the EIA report satisfies the Environmental Code.

Businesses consider that EIA is required for an excessive range of activities whose potential impact is rather low and that the procedure is too burdensome. To reduce this administrative burden, the government intends to further simplify the EIA provisions. This will involve clarifying requirements for the content of environmental impact statements and for consultations, as well as excluding some activities with minor environmental impact from EIAs. The respective legislative changes were proposed in 2012, but need further review in light of recent amendments to the EU Environmental Impact Assessment Directive (2011/92/EU).

2.3. Land-use planning

The Swedish government's main focus in the field of spatial planning is to promote a sustainable built environment (which corresponds to one of the EQOs). In 2012, the NBHBP developed "Vision Sweden 2025", which identifies the built environment and infrastructure needed by 2025 to fulfil the objectives of a sustainable society by 2050. At the same time, continuing urban sprawl and the declining area of agricultural land remain a concern.

The Planning and Building Act of 2011 (which replaced the 1987 Act) regulates the planning process, where municipalities have a primary role. Municipalities have a "planning monopoly": any significant land-use change (including with regard to coastal areas) must be based on a municipal plan. With only a few exceptions, municipalities have a right of veto in planning matters. CABs monitor the handling of national interests in municipal planning, as well as co-ordinate land-use matters concerning several municipalities. The NBHBP provides municipalities with guidance and best practice examples.

Municipalities use two main planning instruments: a comprehensive plan and a detailed development plan. A comprehensive plan describes the main features of the intended use of land, water and coastal zone areas in the municipality and demonstrates how the municipality intends to observe the national EQOs. As the municipality's internal management and co-ordination tool, the comprehensive plan must be both strategic for the long term and provide guidance for particular planning, construction and permitting decisions; it is not legally binding. A detailed development plan, which is legally binding for specific development projects, contains the details of such decisions and stipulates the obligations and rights of the municipality and land owners. Both comprehensive plans and detailed development plans should be adopted only after consultation with various stakeholders, including the CAB, other potentially affected municipalities and the public.

The national government can intervene with respect to areas or objects of "national interest", a status which, according to the Environmental Code, can be assigned for reasons of nature conservation, cultural heritage, outdoor recreation and defence, among others. These sites of national interest include notably coastal and mountain areas, as well as shorelines of lakes and rivers. The national government can also intervene if land-use decisions are not properly co-ordinated among concerned municipalities or if a settlement is inappropriate with respect to the risk of accidents, flooding or erosion.

When an authority or municipality establishes or changes a plan or programme that may entail a significant environmental impact, it must conduct a strategic environmental assessment (SEA).[5] A detailed development plan must always undergo an SEA, although

Box 2.4. **Land-use policies in Stockholm**

The Stockholm Metropolitan Region has several planning documents that determine its spatial development: the Regional Development Plan and the comprehensive plans of the different municipalities in Stockholm county.

The Regional Development Plan (adopted by the Stockholm County Council in 2010) establishes long-term goals to guide urban development through 2050. It incorporates green land-use planning and transport goals, including "a resource-efficient and accessible settlement structure". The plan seeks to integrate "green" and economic objectives using principles of sustainability. For example, the plan mentions an efficient spatial structure for low carbon emissions and accessible public transport.

Similar to the Regional Development Plan, the comprehensive plan of Stockholm City uses the "green" approach to land use and transport policy, focusing on existing urban centres and connecting them with environmentally efficient public transport. The city's environment programme also has a number of land-use targets to minimise urban expansion, particularly into land and water areas of special significance for biodiversity and recreation.

Source: LSE Cities (2013), *Stockholm: Green Economy Leader Report*.

activities that have undergone an EIA as part of the environmental permitting process are given less scrutiny. At the same time, the integration of environmental concerns into comprehensive plans (and the quality of SEAs) varies greatly among municipalities. In this context, the OECD previously recommended that Sweden give greater importance to environmental concerns in spatial planning by harmonising the provisions of the Environmental Code and the Planning and Building Act, and by improving municipalities' implementation capacity (OECD, 2004).

The new Planning and Building Act has led to several improvements in how the areas of planning, building and housing deal with environmental issues. For example, it stipulates that planning must consider aspects related to the environment and climate change (both mitigation and adaptation). Municipal comprehensive plans must also describe how they intend to take national and regional goals, plans and programmes into account for sustainable development. In 2009, to strengthen local government capacity in this area, SEPA issued a handbook with general guidelines on environmental assessment of plans and programmes.

Still, the integration of environmental concerns into spatial planning remains insufficient. In 2012, the NBHBP surveyed municipal comprehensive plans approved between 2005 and 2010: only 10% fully integrated the EQOs; 80% discussed the EQOs only in connection with the SEA; and another 10% did not mention them at all. Only a few coastal municipalities have integrated coastal zone management considerations into their comprehensive and detailed development plans (Chapter 5). Local interests continue to drive municipal planning decisions, often to the detriment of environmental protection. In addition, the co-ordination of municipal planning decisions by regional authorities is very weak.

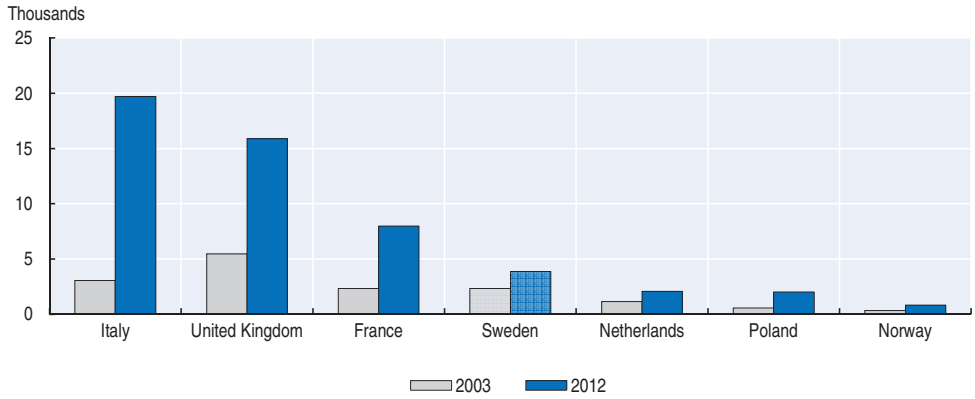
Many environment-related requirements in the area of land-use and building regulations are set at the municipal level and, as a result, may vary from one location to another. For example, local authorities set energy efficiency standards for buildings with different degrees of stringency, creating unequal conditions across the country for construction

companies. To remedy this situation, the central government is considering the modification of existing national standards in this area. However, there is a concern that national energy efficiency standards for buildings will discourage more environmentally progressive municipalities from pursuing more ambitious environmental goals. This concern could be addressed by designating those standards as minimum performance requirements and introducing energy efficiency benchmarking across local authorities.

2.4. Non-regulatory instruments

Different kinds of environmental management systems (EMSs) are widely adopted in Sweden. The number of certifications to the ISO 14001 EMS standard grew by 67% between 2003 and 2012; the absolute number of certified installations (3 885 in 2012) is much greater than in other European countries with similar GDP levels (e.g. Norway and Poland). The growth (Figure 2.1) is much slower in comparison with some other EU member states: in France, the number of certified installations grew by 240% over the same period, and in Italy by about 540%. The vast majority of large Swedish businesses obtained EMS certification in the 1990s, which is the most likely explanation for the relatively slow growth of certification in the 2000s.

Figure 2.1. **Number of ISO 14001 certifications in selected OECD member countries in 2003 and 2012**



Source: ISO (2012), "The ISO Survey of Management System Standard Certification (1999-2012)", ISO Survey (database).

StatLink http://dx.doi.org/10.1787/888933145095

Responding to the previous OECD review's recommendation to further encourage companies to use a standardised EMS (OECD, 2004), the Swedish government has carried out a number of EMS support programmes, some of them run by the Swedish Agency for Economic and Regional Growth. The Swedish Environmental Management Council (SEMCo)[6] has been receiving a government grant of SEK 500 000 per year to promote the Eco Management and Audit Scheme (EMAS), including among small and medium-sized enterprises (SMEs). However, the number of EMAS registrations has decreased over the last five years (there are fewer than 40 across the country). This drop is mainly due to the low market demand for EMAS certification and its relatively high implementation cost, especially for SMEs. About 650 companies and organisations have a diploma of conformance to Svensk Miljöbas – a national EMS standard, which is a simplified version of ISO 14001.

To promote environmental management in the public sector, the government issued an ordinance in 2009 requiring all 190 Swedish government agencies to have an environmental management system that integrates environmental considerations into their activities. In 2007, new government guidelines required state-owned enterprises to publish sustainability reports based on the Global Reporting Initiative (GRI). These reports must explain how the company's business operations take into account environmental and social concerns. As of 2012, state-owned companies are required to set sustainability targets and define strategies to achieve them. Starting in 2014, the government will monitor each company's progress towards these targets.

Sweden is among the few OECD member countries, alongside Canada and the United States, with a scheme to certify environmental product declarations (EPDs); the goal is to provide relevant, verified and comparable data on the environmental impact of goods and services. An EPD is a verified document that reports a product's environmental data based on life-cycle assessment and other relevant information in accordance with the ISO 14025 standard. SEMCo acts as the programme operator for the entire international EPD system.

The ISO 26000 guidance on social responsibility, where the environment is one of seven core subjects, has been available to all companies and organisations since 2010. The Nordic Strategy for Corporate Social Responsibility, adopted by the Nordic Council of Ministers in 2012, declares promoting internationally agreed standards and guidelines as one of its priorities.

Eco-labelling is widespread in Sweden. More than 1 100 Swedish companies market over 6 500 products certified with Nordic Ecolabel (also known as the "Nordic Swan"), a scheme operating in Nordic countries since 1989. Since the Nordic Ecolabel is so well established in Sweden, there are not many EU Ecolabel-certified products on the Swedish market.

The government uses different tools to stimulate the greening of Swedish industry. In 2007, it issued a strategy for strengthening environmental considerations in public procurement; this was conceived as a tool to help the public sector increase demand for, and deployment of, environmental and clean technology (Chapter 3). Most progressive businesses in three industrial sectors (producers of toys, textiles and cosmetics) have volunteered to phase out hazardous substances beyond legal requirements. A voluntary agreement commits a number of energy-intensive industries to reducing emissions deeper than required in exchange for paying lower rates of the energy tax.

3. Environmental compliance assurance

3.1. Promotion of compliance and green business practices

Over 94% of Swedish firms in the manufacturing sector have fewer than 20 employees; fewer than 1% of firms have more than 250 employees. While SEPA considers providing advice and information to SMEs to be an essential element of compliance assurance, such compliance promotion activities are conducted exclusively at the regional and local levels. Instruments used range from direct advice during inspections to information via brochures, seminars, etc.

These practices vary greatly across municipalities. As a result, SMEs generally find it hard to find information about new regulatory requirements and the best ways to comply with them. SEPA has not provided guidance to the competent authorities on compliance promotion strategies, and no single website provides SMEs with sector-specific compliance-related

information. Part of the problem appears to be a series of reorganisations that resulted in SEPA losing much of its industrial sector expertise; it may no longer have sufficient capacity to provide sector-specific guidance on compliance and green business practices.

The Swedish Agency for Economic and Regional Growth is generally responsible for supporting small businesses. Most of its green business initiatives target SMEs that offer green products or services, especially potential exporters; roughly 100 000 of about 900 000 SMEs claim to be part of the "green market". Several other agencies are running programmes promoting resource and energy efficiency among SMEs. For example, the Energy Agency offers SMEs "energy audit vouchers" covering 50% of energy audit costs. The Ministry of Rural Affairs supports resource and energy efficiency in the agriculture, forestry and fisheries sectors. Every municipality has an energy and climate advisor who provides energy efficiency guidance to small businesses and households (Chapter 4).

However, these government programmes do not provide small businesses with compliance-related information and incentives. There is also little exchange of best practices in compliance promotion across different municipalities and regions. To a certain degree, industry organisations fill this information gap by helping their members and larger businesses assist their SME suppliers. Those actors, however, usually get their information from sources other than the government. In contrast with some other OECD member countries, Swedish companies do not receive any regulatory incentives from competent environmental authorities (in terms of reduced inspection frequency, reduced permit fees, etc.) for the implementation and certification of sound environmental management practices.

3.2. Compliance monitoring and enforcement

While SEPA supervises implementation of a major part of the country's Environmental Code, several other government agencies also have environmental compliance monitoring functions (e.g. the Chemicals Agency has its own staff of 35 inspectors).[7] CABs have responsibility for inspection of installations covered by a permit and for supervisory guidance to municipalities. A municipal EPHC can request the delegation of inspection tasks to it for certain categories of installations. The CAB then makes a decision based on the local authorities' competence and resources. The 2011 Environmental Inspection and Enforcement Ordinance clarified the rules and responsibilities of different authorities at the central, regional and local levels. In particular, it strengthened the rules for CABs to delegate and withdraw compliance monitoring and enforcement responsibilities to and from local authorities. CABs can retain supervision over certain environmentally hazardous activities if they consider this to be more efficient.

Currently, about 60% of compliance monitoring has been transferred to municipalities. CABs have inspection responsibilities for approximately 2 700 sites, of which over 300 are A-activities. Municipalities are in charge of inspecting around 4 800 sites, of which over 100 are on the A list. The number of sites in which local authorities have taken over compliance monitoring differs significantly across counties. In the city of Örebro, for example, the local EPHC inspects all installations on its territory except those that are municipality-owned, like wastewater treatment plants.

The quality and breadth of compliance monitoring also vary significantly among municipalities, which creates uncertainty, and different requirements, for businesses operating across the country. In its 2007 report, the Committee on Public Sector Responsibilities concluded that local-level inspections must be better co-ordinated.

Inspections at the regional level are funded from the general budget (permitted installations pay an annual fee to the treasury if they are inspected by a CAB). The funding for municipal EPHC inspections comes in part from local taxes and partly (sometimes up to 75%, as in Linköping) from inspection fees paid by operators (annual for hazardous facilities and per hour of inspection for others). SALAR provides municipalities with guidelines for charging inspection fees, but municipalities set the rates themselves.

The previous OECD review recommended that Sweden improve national oversight of compliance monitoring, enhance risk-based targeting of inspections and strengthen administrative and judicial sanctions (OECD, 2004). Sweden has made progress in these areas, as discussed below.

National oversight

SEPA has issued a *Guidebook on Operational Inspection* that aims at ensuring the relative uniformity of compliance monitoring practices across the country. SEPA also provides information and guidance about new legislation within its remit, publishes the Inspection News bulletin and organises training courses and seminars for environmental inspectors. CABs also provide guidance to municipal EPHCs, mostly by visiting them (though at irregular intervals). However, CABs would like to have more guidance from the national level on how to best oversee municipalities' supervisory activities.

SEPA is required to submit an annual report to the government about the status of compliance monitoring and enforcement activities across the country. However, the report's quantitative information concerns only outputs (activities) such as the number of inspections, enforcement cases, etc., but not their outcomes. In addition, many competent authorities are not convinced that the value of routine reporting is worth the effort required by sub-national and local enforcement officials. In 2012, SEPA received the recommendations of a three-year "effective environmental inspections and enforcement" research project, which reflected on possible methods for evaluating the country's environmental supervisory authorities. SEPA is considering ways to gradually introduce procedures, as well as a number of uniform indicators for performance measurement and reporting of sub-national and local supervisory authorities (see also Section 1.4).

Risk-based inspection targeting

The 2011 Inspection Ordinance obliges every supervisory authority in Sweden to prepare a comprehensive annual inspection plan based on its compliance monitoring priorities, i.e. on those activities and installations that are important for meeting regional and local environmental targets. Unplanned inspections usually account for just 20-25% of the total, which demonstrates successful risk-based targeting of compliance monitoring. However, each CAB uses its own method (electronic spreadsheets, paper scoring sheets, etc.) of accounting for different risk factors and determining the inspection frequency for specific installations, with available resources being a major element of operational planning. Most Swedish municipalities plan their inspections based on the requirements of the national ordinance on environmentally hazardous activities and health protection (1998), as well as the guidance developed by SALAR. The type and size of a facility and the quality of its self-monitoring programme are assessed and taken into account when determining the inspection frequency and fee charged by the municipality.[8]

In addition, issue-specific national or regional inspection campaigns are conducted quite frequently. Such campaigns involve both CABs and municipalities and draw upon

standard inspection manuals or checklists. At the same time, Swedish industry complains about the absence of a sectoral approach to environmental regulation and compliance assurance; this absence is partly explained by the erosion of sector-specific expertise in SEPA and the lack of relevant technical capacity at the local level.

Enforcement sanctions

The system of environmental sanctions was streamlined in the 2006 amendments to the Environmental Code. The law does not give supervisory authorities any discretion in determining monetary penalties.[9] A specific ordinance defines a list of about 50 infringements for which the supervisory authority must impose administrative "sanction fines". It also lists precise amounts for the fines, ranging from SEK 5 000 to 1 million; the central government does not collect statistics on the use of environmental enforcement sanctions. These administrative fines are imposed without regard to the intent or negligence of the violator or the environmental damage caused. Nor do the fines account for the possible benefit enjoyed by the violator as a result of the infringement, which may substantially impair their deterrent effect. Revenues from the fines go to the state treasury, a common practice in OECD member countries.

In addition to a fixed fine, the supervisory authority may combine a compliance order with a conditional fine; this corresponds to the costs estimated by the authority of the corrective actions prescribed by the order. If the operator does not comply with the order, the supervisory authority may turn to a Land and Environment Court to impose the fine. Conditional fines are widely and effectively used as an incentive tool but are rarely levied, as the vast majority of operators return to compliance in the prescribed timeframe.

The Environmental Code lists the criminal offences that carry a penalty of a judicial fine or imprisonment not exceeding two years (as determined by a general court of law). A supervisory authority must report all discovered infringements to the public prosecutor. Submissions for prosecution are handled by a public prosecutor with specific responsibility for environmental crimes; a prosecutor's jurisdiction covers several counties.

The 2007 amendments to the Environmental Code prevent double penalties under administrative and judicial enforcement. Therefore, a supervisory authority cannot impose administrative fines and refer the case to the public prosecutor at the same time: the more serious offences are referred for prosecution, while less serious ones are subject to administrative enforcement. However, the prosecutor's office, and not the supervisory authority, determines whether a particular criminal offence is likely to lead to a conviction or may be considered minor.

In practice, less than one-third of all criminal enforcement cases referred to a prosecutor are actually pursued. This leaves an important number of relatively serious offences unpunished, thereby creating an enforcement gap. In addition, a consistently high proportion of cases referred by inspectors but not pursued by prosecutors erodes the inspectors' credibility in the eyes of the regulated community; these cases can be returned to the enforcement authority for administrative sanctions, but this rarely happens) As a result, many local EPHCs have stopped referring certain types of cases to the prosecutors because, on the basis of past experience, they expect that no action will be taken (so it does not make sense to spend time and resources on them). The National Council on Crime Prevention signalled the issue of an enforcement gap at the municipal level in a 2006 report, but the problem seems to persist.

If a prosecutor decides to pursue a case, the environmental police investigate it further, and it is submitted to a general court of law (with a notification sent to the supervisory authority). There also appears to be a large divergence between court decisions on environmental cases, due in part to the lack of guidance for judges on the application of the Environmental Code.

3.3. Environmental liability

The Environmental Code initially addressed only "traditional" damage (bodily injury, material damage or financial loss) due to water, air or soil pollution; alteration of the groundwater level; and damage from noise, vibration or similar impacts. Following the transposition of the EU Environmental Liability Directive (ELD, 2004/35/EC), it now also imposes liability for damage to the environment (water, land and biodiversity). In 2012, Parliament approved new regulations on the responsibility of industrial operators for restoring damage to land and groundwater when closing down their operations. However, there are very few ELD-regulated environmental liability cases in Sweden, mainly because most contaminated sites originate from before 1969 (when Sweden's first environmental laws went into effect) and are addressed by the government.

Before 2010, operators of environmentally hazardous activities subject to permit or notification requirements had to contribute annually to an environmental damage insurance scheme (for traditional damage) and an environmental remediation insurance scheme (for environmental damage). The environmental insurance schemes were to be activated under three scenarios: if the person who caused the damage did not have the financial resources to pay; if the statutory limitation period for traditional damage compensation claims had elapsed; or if it was impossible to determine the party responsible for the damage. However, the conditions established by the government for these insurance schemes appeared to be too restrictive. Consequently, competent authorities doing the clean-up would not file compensation claims with insurance companies to cover the costs of their remediation. Indeed, over the eight years of its existence, the remediation insurance scheme only disbursed just over SEK 6 million, whereas insurance premiums collected over the same period totalled SEK 120 million. As a result, the government abandoned the mandatory insurance schemes and began financing remediation of old "orphan" contaminated sites from the general budget. Companies can still choose to buy insurance to cover their current environmental liability, which is consistent with the ELD.

Of approximately 80 000 contaminated sites in Sweden, some 1 500 pose a major environmental and human health risk. So far, private responsible parties have treated about 2 000 contaminated sites, and the government has paid for remediation of about 100 abandoned sites. There are no national land decontamination standards, and the scope of remediation is determined case by case based on expert judgement (consultants' recommendations). Private operators complain that this leads to inconsistent and often excessively costly implementation of liability rules. At the same time, public funding for environmental remediation appears to be insufficient: the government considers that the annual budget allocation of SEK 400-500 million for the remediation of "orphan" contaminated sites will be insufficient to reach the "non-toxic environment" EQO by 2020.

4. Promoting environmental democracy

4.1. *Environmental information*

As recommended by the previous OECD review, Sweden ratified the Aarhus Convention on Access to Information, Public Participation in Decision making and Access to Justice in Environmental Matters in 2005. The ratification made necessary certain national implementation measures, even though Swedish law had already guaranteed most of the convention's rights of access to environmental information. A new Environmental Information Act (2005) was introduced to complement the fundamental principle of public access to official documents in public administration. It guarantees access to environmental information even in cases where this information is held by private entities executing public service functions. Official documents that are not covered by secrecy provisions are public according to the Freedom of the Press Act. According to the Public Access to Information and Secrecy Act (2009), information on pollution releases to the environment is open to the public.

The Geographical Environmental Information Act was adopted in 2010 to implement the 2007 EU Directive (2007/2/EC) establishing an Infrastructure for Spatial Information (INSPIRE). This act created a system for authorities, municipalities and certain private bodies to exchange spatial data in electronic form and provide public access to it. As a result, several Internet information sources have been established under the geodata portal of the National Land Survey. More than 100 Swedish public organisations, including SEPA, have joined the project.

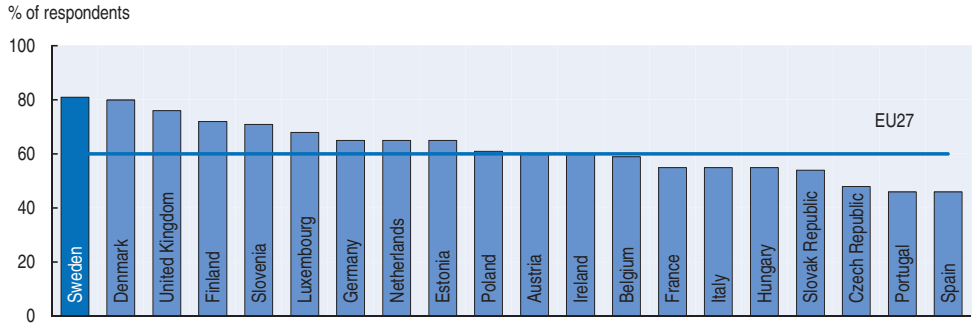
SEPA has developed an environmental data portal allowing civil servants and the general public to search for and download environmental information and publications. In early 2013, SEPA launched its new website, whose "State of the Environment" page provides links to databases of many environmental authorities at all administrative levels. As part of the implementation of the UNECE Protocol on Pollution Release and Transfer Registers (PRTRs), which Sweden ratified in 2008, the SEPA website now features a database of pollution releases of about 1 000 of the largest Swedish enterprises classified as posing environmental hazards.

According to the 2011 Eurobarometer survey of attitudes of European citizens towards the environment (European Commission, 2011), 81% of Swedes believe themselves to be well informed about environmental issues, which is 11% more than in 2007. Swedish citizens' degree of satisfaction with the level of environmental information they receive is the highest among EU member states (where the average is 60%, Figure 2.2); the improvement rate is double the EU average of 5%. This testifies to the success of the Swedish government's efforts to both provide access to, and proactively disseminate, environmental information.

4.2. *Public participation in environmental decision making*

Sweden's Environmental Code guarantees the public's right to participate in environmental assessment and permitting decisions. Over the years, environmental non-governmental organisations (NGOs) have played an important role in the environmental permitting process by contributing their expertise and challenging both operators and permitting authorities to justify their positions. The Swedish government provides substantial financial support to environmental NGOs. The previous OECD review had recommended further development of public participation and encouragement of citizen

Figure 2.2. **Public satisfaction with environmental information in EU-member OECD countries in 2011**



Note: Percentage of respondents who replied "well" (in total) to the question "Do you consider that you are very well, fairly well, fairly badly or very badly informed about environmental issues?". Survey conducted between 13 April and 8 May 2011.
Source: European Commission (2011), "Attitudes of European citizens towards the environment", *Special Eurobarometer 365.*

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initiatives at regional and local levels. Accordingly, under the new Planning and Building Act, NGOs obtained a strengthened right to be heard on matters related to local plans with a significant environmental impact. NGOs are also important stakeholders in the design and implementation of the EQO system (Section 1.3).

With respect to access to justice, Sweden's accession to the Aarhus Convention has also reinforced the right of environmental NGOs to take legal action. The provisions of the Environmental Code concerning NGOs' right to appeal against certain types of environmental decisions have been clarified. Since 2007, environmental NGOs have had an explicit right to appeal specific provisions of an environmental permit and to apply for judicial review of permitting decisions. Furthermore, the right to appeal has been expanded to more NGOs: the required number of members was reduced from 2 000 to 100, although they must prove they have conducted activities in Sweden for at least three years. It has recently been proposed to extend the right of appeal to international NGOs not necessarily based in Sweden. Waiving legal fees associated with filing an appeal further facilitates NGOs' access to justice.

4.3. Environmental education

Sweden has a long-standing tradition of environmental education, which is understood as a key element of progress towards sustainable development. Teaching of basic environmental issues begins at the pre-school level and expands in primary school. The recently updated (2011) secondary school curriculum covers sustainable development aspects in several subjects. The new guidance documents mark a shift from the concept of environmental education towards the concept of education for sustainable development, including ecological, social and economic sustainability. According to a survey of 15-year-olds conducted by the OECD Programme for International Student Assessment (PISA), Swedish schools play a bigger role in teaching children about most environmental issues, on average, than schools in other OECD member countries. For example, 65% of children in Sweden learn about water shortages and 71.6% learn about nuclear waste issues at school, against fewer than 59% on both counts for OECD member countries on average (OECD, 2009).

According to the Swedish Higher Education Act (1992), higher education institutions should promote sustainable development. Since 2011, all public universities and colleges

must report annually to the government on their environmental work. Several have been certified to the ISO 14001 EMS standard.

The "School for Sustainable Development" project run by the National Agency of Education provides annual awards to schools with achievements in sustainable development; to date, 400 schools have received such an award. In addition, over 2 500 Swedish schools have been awarded a Green Flag – an international distinction under the Eco-Schools Programme that is co-ordinated nationally by the Keep Sweden Tidy Foundation.

Notes

1. While the county administrations are financed from the national budget (with roughly half coming from the Ministry of Finance and the other half comprising targeted grants from other central government agencies), municipalities have the power of taxation and collect about one-third of overall tax revenue.
2. There are currently around 350 government agencies in Sweden; each ministry is responsible for a number of agencies. The ministry determines general policy and allocates resources for the agencies' activities, but does not decide how agencies should apply a law or what decision they should take in specific cases.
3. The committee includes eight members (parliamentarians of the ruling and opposition parties), seven special advisors (representing regional and local governments, the business sector and NGOs) and six experts.
4. According to a 2012 government ordinance, the EADs must consult each other and harmonise their processes.
5. Although Sweden has transposed into its legislation the provisions of the EU Directive on Strategic Environmental Assessment (2001/42/EC), Swedish authorities often refer to SEA as environmental impact assessment and do not make a distinction between the two instruments.
6. SEMCo, a Swedish government body, provides expertise to public authorities and the private sector on environmental procurement and corporate environmental management.
7. The Chemicals Agency conducts chemicals safety inspections of manufacturing and importing businesses, while municipalities inspect retailers handling potentially dangerous products.
8. The fee also influences inspection targeting, as the EPHC needs to "deliver" the inspection hours that operators are paying for (in the case of annual fees).
9. Other possible administrative sanctions are full or partial suspension of the environmental permit or reconsideration of some of its conditions by the permitting authority.

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PART I

Chapter 3

Towards green growth

Sweden is a forerunner in eco-innovation and in environmental taxation. This chapter assesses Sweden's environmental tax system since the "green tax shift" triggered by the 2001 reform. It discusses how the country could remove environmentally perverse incentives in the energy and transport sectors. It also examines the subsidies designed to encourage investment in the environment and the promotion of eco-innovation. Finally, Sweden's efforts to mainstream the environment in development co-operation programmes are reviewed.

Assessment and recommendations

Sweden is a forerunner in environmental taxation and in the use of economic instruments more generally. In the 2000s, Sweden introduced taxes on landfilling waste, a carbon dioxide (CO_2)-based tax on cars and congestion charges in Stockholm and Gothenburg. In the first half of the 2000s, the government implemented the so-called "green tax shift": the CO_2 tax rate was substantially raised and now is among the highest in the world, while income taxes were reduced, especially on lower-income households. Sweden is one of the few countries that managed to increase environmentally related taxes and reduce the tax burden on labour, thereby neutralising the potentially negative impact of environmentally related taxes on income distribution. There is evidence that tax and pricing instruments have contributed to reducing environmental externalities, including greenhouse gas (GHG) emissions, and promoted the adoption of cleaner technologies.

However, much of the progress in environmental taxation dates back to the 1990s or early 2000s. Tax revenue as a share of gross domestic product (GDP) and of total tax receipts decreased in the second half of the 2000s, reaching 2.5% of GDP and 5.7% of tax revenue. Tax rates are not systematically adjusted for inflation, which weakens their incentive function over time. Although the NO_x charge proved to be effective in the past, its design could be improved, as well as that of the CO_2-based annual vehicle tax. Given the range of ambitious environmental objectives ahead, it would be timely to consider further extending the use of environmentally related taxes and pricing instruments, especially in areas other than energy use, while reducing other taxes.

There is no systematic, consistent and comprehensive analysis of environmentally harmful subsidies, but estimates by the Swedish Environmental Protection Agency indicate they amounted to about 1.4% of GDP in 2010. Despite recent progress in reducing exemptions from energy and carbon taxes, several exemptions remain that can reduce the incentives to use energy efficiently in sectors outside the European Union emission trading system, including industry, mining, agriculture, forestry and fishing. The favourable tax treatment of biofuels is not a cost-effective way to abate GHG emissions. The energy tax on diesel is half that on petrol, but burning diesel in vehicles generates higher levels of local air pollutants. The higher vehicle tax applied to diesel passenger cars is an inadequate substitute for the reduced fuel tax. There are also other potentially perverse incentives, including generous tax treatment of company cars and commuting allowances.

Several support programmes aim to promote renewable energy sources and energy efficiency, help mitigate GHG emissions and improve environmental performance of agriculture. These programmes have encouraged businesses and households to make "greener" investments. For example, industry expenditure for environmental protection significantly increased. Questions remain, however, about whether such investments would have been made without support and the resulting windfall gains. In addition, there is room to improve the transparency of such measures in budget reporting. Sweden does

not regularly publish complete information about public expenditure on environmental protection (for example, expenditure on wastewater management is missing).

As in other European countries, municipal waste and wastewater treatment account for more than half of public environmental expenditure, which is mostly incurred by municipalities. Water charges are extensively applied and cover nearly all financial costs of service provision, but covering the cost of infrastructure maintenance and renewal is a challenge. In addition, the contribution of different water users (households, agriculture and industry) to cost recovery is unclear. There is no national methodology for including environmental and resource costs in the calculation of cost recovery. Regulatory changes have promoted private participation and competition in the sector, which nonetheless remains limited. Pay-as-you-throw charging systems for municipal waste are used countrywide and broadly allow recovery of service costs. Landfill bans, along with tax and producer responsibility schemes, have contributed to diverting municipal waste from landfills and to increasing waste recovery, in particular from incineration. However, the impact of these measures on waste prevention is unclear. Incineration capacity has expanded well beyond the amounts of domestically generated waste. As an effect of removing the incineration tax in 2010, incentives to import waste for incineration increased.

Eco-innovation is an important component of Sweden's environmental policy. Since the mid-2000s, the government's research and development budgets for environment and energy have grown in support of Sweden's energy and climate objectives. In 2009-11, Sweden was the third most innovative OECD member country in environment-related technologies in terms of patents per capita, and the fourth in terms of patents per GDP. Strong environmental and innovation policies have helped Sweden develop clusters in energy and environmental technologies at European and world scale. However, the environmental goods and services sector remains relatively small. The multiplicity of funding bodies and programmes may have hampered the development of larger-scale research initiatives. It also makes it difficult to identify the best funding opportunities, especially for small and medium-sized enterprises. The Swedish government launched a strategy for the development and export of environmental technologies over 2011-14. Early assessment has shown a potential for better focusing support on industries at risk of losing their competitive advantage because of a low rate of green innovation activity.

In 2012, Sweden was the second most generous member of the OECD Development Assistance Committee (DAC) with 1% of its gross national income given as official development assistance, well above the UN target of 0.7%. "Environment and climate change" has long been a priority of Swedish development co-operation. In 2010/11, environment-focused aid represented 52% of bilateral aid, the third highest share among donors in the OECD DAC. Still, despite regulatory requirements, environmental impact assessments have not been systematically conducted, and more could be done to mainstream environmental and climate aspects in aid activities, including training staff and increasing dedicated resources.

Recommendations

- Assess the economic benefits of environmental measures and how they could contribute to green growth, e.g. by contributing to competitiveness and employment.
- Consider further extending the use of environmental taxes and pricing instruments, especially in areas other than energy use, while possibly reducing other taxes; for example, consider introducing taxes on fertilisers, hazardous chemicals and activities harmful to ecosystem services, and removing the refund mechanism for the NO_x charge; and ensure that all rates are systematically adjusted to maintain the incentive and revenue-raising functions of taxes.
- Systematically evaluate the incentive mix in the transport sector, including motor fuel taxes and vehicle taxes, the tax treatment of biofuels and the taxation of company cars and commuting allowances; reform the tax treatment of company cars; and increase the energy tax rate on diesel, with a view to reaching energy tax parity with petrol.
- Regularly assess the potential environmental consequences of tax expenditure and other subsidies, possibly as part of the annual survey of tax expenditure conducted by the Ministry of Finance.
- Systematically evaluate the cost effectiveness of environmentally motivated subsidies with a view to maximising their environmental impact, while reducing overlaps and potential windfall profits; and improve budget reporting of such subsidies.
- Carefully assess the environmental and economic impacts of incineration overcapacity.
- Improve transparency in water pricing policy for different sectors with a view to more fully implementing the polluter- and user-pays principles; include environmental and resource costs in the calculation of cost recovery; and further promote more efficient delivery of water services through inter-municipal co-operation and, where appropriate, private sector participation.
- Reinforce efforts to develop and disseminate environmentally related technologies by streamlining funding programmes and scaling-up centres of research excellence; considering the introduction of binding environmental requirements in public procurement procedures; maximising the leverage of private capital; and continuing to assess the outcomes of policies intended to promote environmentally related innovation.
- Maintain the strong commitment to environment and climate in Sweden's development co-operation; ensure that environmental and climate considerations are systematically addressed in all aid investments and activities; and ensure that staff are trained and adequate resources are allocated for this purpose.

1. Greening the tax system

Like other European Nordic countries, Sweden has long made use of economic instruments in environmental policy, covering a wide range of sectors (Table 3.1). Sweden was among the first to introduce a number of environmentally related taxes in the early 1990s, including taxes on emissions of carbon dioxide (CO_2) and sulphur oxides (SO_x), as well as a charge on nitrogen oxides (NO_x) emissions. Other instruments have been introduced in the last 10 years, including congestion charges, CO_2-based vehicle taxes, the renewable electricity certificate system and Sweden's participation in the European Union emission trading system (EU-ETS) (Chapter 4).

Table 3.1. **Overview of economic instruments in use in Nordic countries as of 2013**

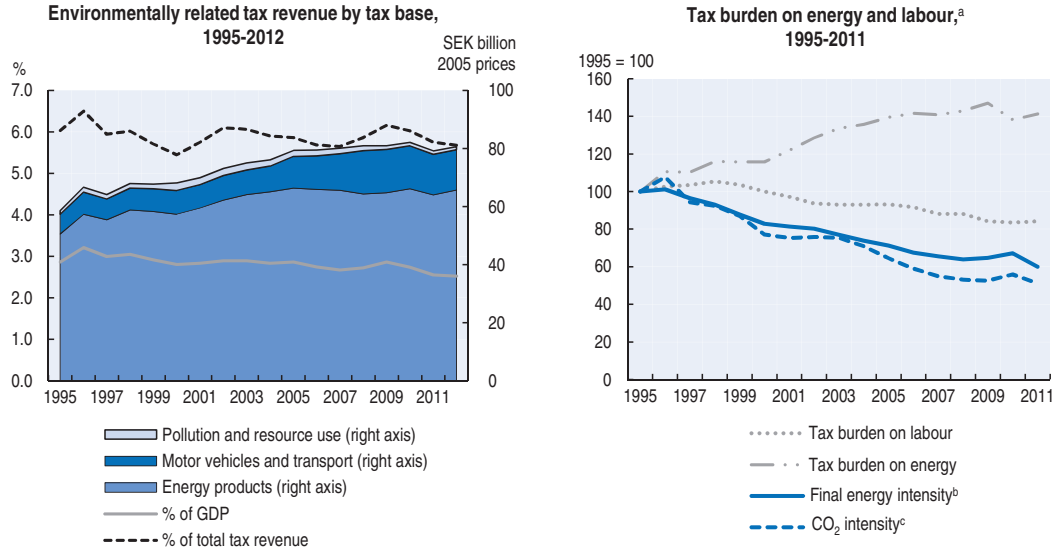
	Denmark	Finland	Iceland	Norway	Sweden
Energy and air pollution					
Excise tax on electricity consumption	X	X	X	X	X
Excise tax on fuel oil products, etc.	X	X		X	X
Excise tax on transportation fuels	X	X	X	X	X
CO_2 tax on fuel oil	X	X	X	X	X
CO_2 tax on transportation fuels	X	X	X	X	X
Inclusion of energy-intensive industries in the EU-ETS	X	X	X	X	X
SO_2 tax	X			X	X
NO_x charge	X			X	X
Green electricity certificates					X
Water pollution					
Water effluent tax	X				
Water supply tax	X				
Waste					
Tax on waste discarded in landfill	X	X		X	X
Tax on incinerated waste	X			X	
Taxes, deposit-refund systems or other collection systems on beverage containers/packaging	X	X	X	X	X
Taxes on other packaging	X				X
Charges to finance collection and treatment or deposit-refund systems for products: batteries from ELVs, tyres, lubrication oil and pesticides.	X	X	X	X	X
Tax on GHGs (industrial gases)	X			X	
Tax on PVC, phthalates and chlorinated solvents	X				
Transport					
Vehicle registration or sales tax	X	X	X	X	
Annual circulation tax	X	X	X	X	X
Environmental or noise charges on aviation		X		X	X
Road congestion tax					X
Inclusion of aviation in the EU-ETS	X	X	X	X	X
Differentiated shipping lane tariffs					X
Agriculture and natural resources					
Tax on extraction of certain raw materials	X				X
Tax on pesticides	X			X	X
Tax on fertiliser use	X				
Tradable fishing quotas	X		X		

Source: Adapted from Bragadóttir, H. et al. (2014), "The use of economic instruments in Nordic environmental policy 2010-2013".

In 2001, the government launched an environmental tax reform programme or "green tax shift" to reallocate taxes from labour to environmentally harmful activities. The programme was intended to shift SEK 30 billion (about EUR 3.25 billion) by 2010 (Speck et al., 2006). Between 2001 and 2006, the government raised EUR 1.6 billion in additional environmentally related taxes while reducing personal income taxes and social contributions, especially with respect to low-income households. The government primarily raised the rate of the CO_2 tax (or carbon tax), but other environmentally related taxes also increased (including on electricity, transport fuels, vehicles, waste landfilling, gravel and pesticides) (Lindhjem et al., 2009). While the government ended the tax shifting programme in 2006, from 2007 to 2013 it continued to increase environmental taxes for EUR 0.6 billion and to cut labour taxes for EUR 8.6 billion.

As a result of the green tax shift, and the progressive increase in energy and carbon tax rates, revenue from taxes on energy use rose by 15% in real terms in the first half of the 2000s (Figure 3.1), while final energy consumption slightly declined. The deflated implicit tax rate (ITR) on energy,[1] which measures taxation per unit of fuel used, also increased sharply. While the taxation burden on energy increased, it decreased on labour income (measured by the ITR on labour),[2] which offset the impact on households. Final energy intensity – or energy used for final consumption per unit of gross domestic product (GDP) – has declined since the last decade, as has the CO_2 intensity of the economy (Figure 3.1). This can be partly linked to the green tax shift, although other factors contributed, including other climate policy measures and soaring world oil prices (Chapter 4).

Figure 3.1. **Revenue from environmentally related taxes in Sweden**



a) Tax burden on labour: ratio between the revenue from taxes on labour income and social contributions and overall compensation of employees; tax burden on energy: ratio between the revenue from energy taxes and final energy consumption.
b) Total final energy consumption per unit of GDP at 2005 prices and PPP.
c) CO_2 emissions from fuel combustion per units of GDP at 2005 prices and PPP.
Source: Eurostat (2013), *Government Statistics* (database); IEA (2013), *IEA CO_2 Emissions from Fuel Combustion Statistics* (database); OECD/EEA (2014), *OECD/EEA Database on Instruments Used for Environmental Policy and Natural Resources Management;* OECD (2013), *OECD Economic Outlook No. 93* (database).

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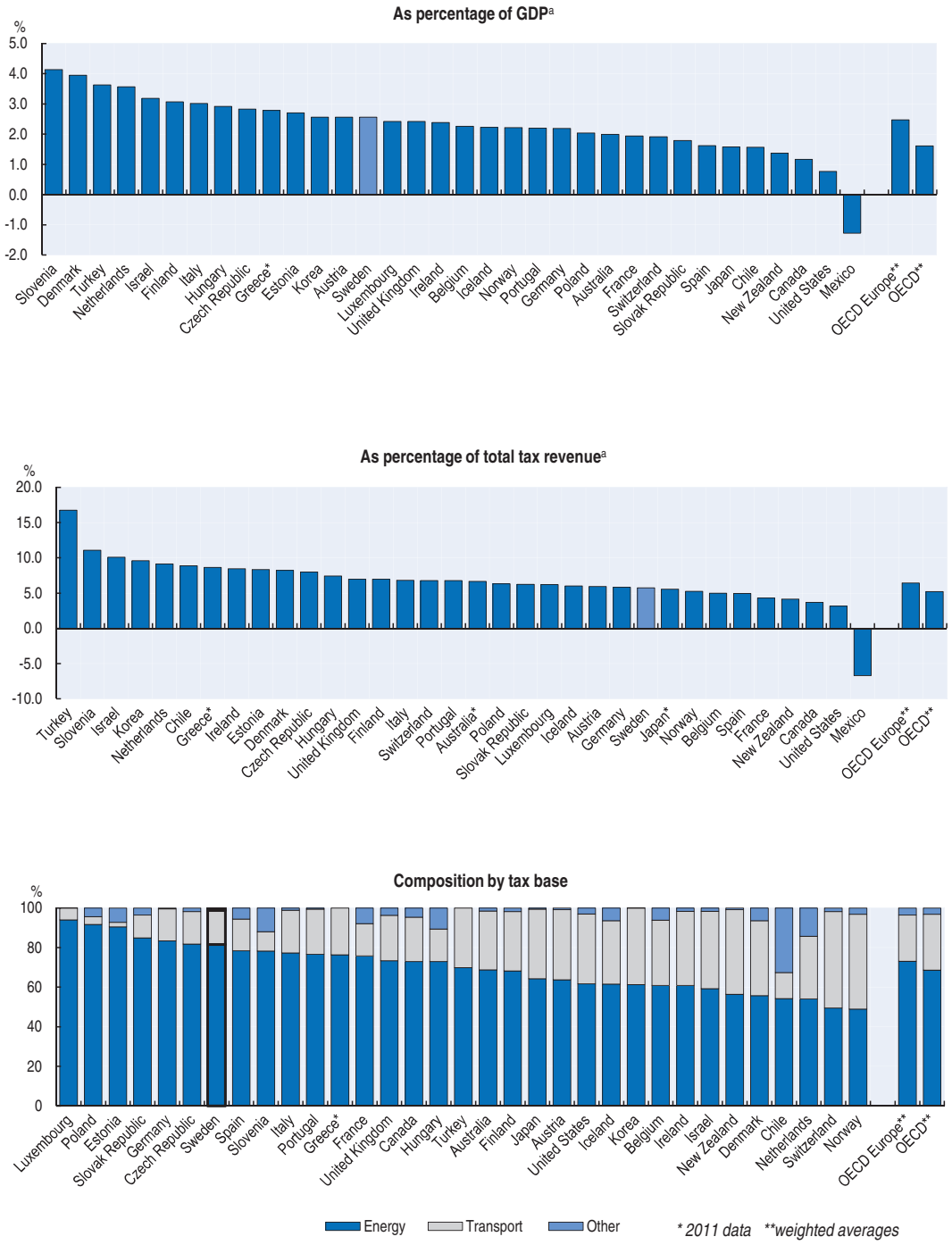
Overall, revenue from environmentally related taxes (in real terms) rose by 16% over 2000-12, and more rapidly in the first half of the 2000s. Between 2003 and 2012, revenue declined from the peak of 2.9% of GDP to 2.5%, partly because of the economic slowdown and lower energy demand (Figure 3.1; Chapter 1). This is in line with the OECD Europe average of 2.5%. In 2012, environmentally related taxes accounted for 5.7% of total tax revenue, which was below the OECD Europe average of 6.4% (Figure 3.2).

Sweden's experience with the green tax shift shows that environmentally related taxes can make the tax system more growth-friendly if revenue is used to reduce more distortionary taxes such as those on labour. According to Sweden's Ministry of Finance, the increase in energy taxation has had no negative impact on economic growth and employment, and overall the tax-to-GDP ratio declined. Several studies indicated that the potentially regressive effect of a green tax reform was nearly neutralised in Sweden. The green tax shift resulted in increased disposable incomes for most income groups, although

Figure 3.2. **Revenue from environmentally related taxes in OECD member countries in 2012**



a) Mexico: the system used to stabilise end-use prices of motor fuels causes tax revenue to turn negative (i.e. to become a subsidy) in years when the international oil price is high.

Source: OECD/EEA (2014), *OECD/EEA Database on Instruments Used for Environmental Policy and Natural Resources Management;* OECD (2013), *OECD Economic Outlook No. 93* (database).

StatLink http://dx.doi.org/10.1787/888933145125

the highest- and lowest-income groups experienced declines. Rural households faced higher costs because of their heavy reliance on private cars for travelling and the lack of reasonable public transport alternatives (EEA, 2011a).

Many factors underlie Sweden's achievement in greening the tax system. These include a general political and public consensus and awareness of environmental issues, including climate change; a thorough economic analysis of the tax proposals and discussions with the business sector; the stepwise increase in tax rates to let the economy adapt to changes in relative prices; the availability of alternatives, such as urban public transport and district heating; the growth of the environmental technology sector (Section 4); and a well-developed social welfare system able to address the distributional impacts of increased taxes (e.g. on low-income households).

However, the green tax shift seems to have lost momentum, as much of the progress in environmental taxation dates back to the 1990s or early 2000s. In addition, despite recent progress, a number of tax exemptions remain that create inconsistencies and inefficiencies in the policy mix (Sections 1.1 and 2.1). There seems to be scope to relaunch a green tax shift by further extending the use of environmental taxes and pricing instruments, especially in areas other than energy use.

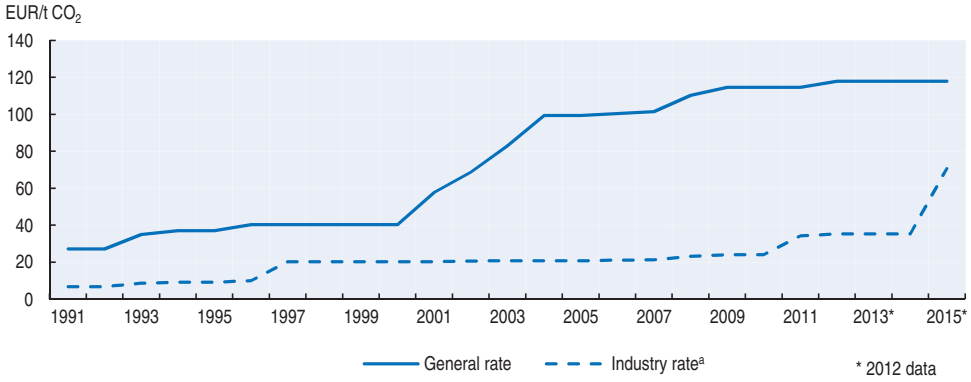
1.1. Taxes on energy products

Most environmentally related tax revenue (82%) comes from energy taxation, including transport fuels and electricity. Energy taxes account for a larger share of environmentally related tax revenue than in many OECD member countries and above the average share in OECD Europe (73%) (Figure 3.2). Taxes on energy products are based on three components: the energy tax, based on the energy content of fuels; the CO_2 tax, based on the carbon content of fuels; and the sulphur tax, based on the sulphur content of fuels (Section 1.3).[3]

When the CO_2 tax was first introduced in 1991, existing energy taxes were simultaneously halved. The government sought to leave the overall tax burden on energy products roughly unchanged, while providing an economic incentive to shift towards less carbon-intensive fuels (for example, the total tax rate – energy and carbon tax – on coal increased markedly). The carbon tax covers most fossil fuels, but excludes peat, and it does not apply to non-fossil fuels such as biomass and biofuels. It generally accounts for the largest part of the duties levied on energy products. The standard nominal carbon tax rate increased considerably in the first half of the 2000s, as a result of the green tax shift. It reached EUR 119 tonne/CO_2 in 2013 (Figure 3.3). This is well above the price of a CO_2 allowance in the EU-ETS and higher than in other Nordic countries that also impose such tax (OECD, 2014). Industry has always benefited from reduced carbon and energy tax rates in response to its competitiveness concerns, although tax rates on energy products remain above the minimum levels required by the EU directive on energy taxation. Since 2009/10, the EU-ETS industry has been exempt from carbon tax, to avoid being regulated twice, while the tax rate has gradually increased for industry outside the EU-ETS (Figure 3.3).

As energy users face both energy and carbon taxes, and can benefit from a number of tax exemptions and rebates, the average effective tax rate on carbon largely differs from the nominal carbon tax rate. Sweden's effective tax rate on carbon equals on average about EUR 79 tonne/CO_2.[4] This is the sixth highest average effective tax rate on carbon in the OECD (OECD, 2013a).

Figure 3.3. **Evolution of the CO_2 tax rates in 1991-2015**



a) As from 2008, data refer to rates for industries outside EU Emissions Trading System (EU-ETS). Data exclude diesel fuel for tractors and other vehicles used in agriculture and forestry sectors.
Source: Country submission.

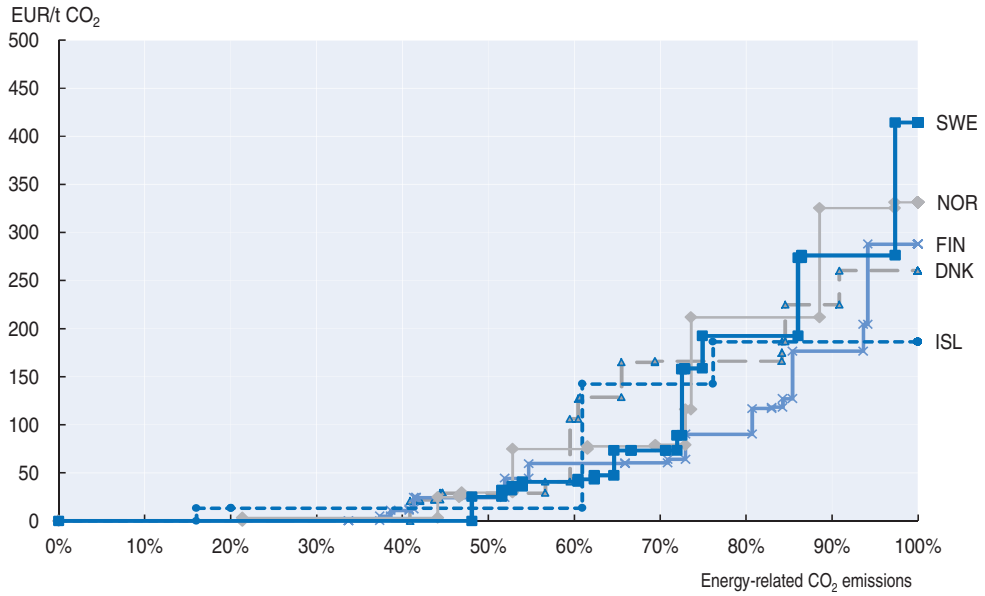
StatLink http://dx.doi.org/10.1787/888933145139

As in all countries, the effective tax rate on carbon largely varies across energy products and sectors of the economy. In Sweden, the effective tax rate on carbon varies from zero on biomass to more than EUR 400 tonne/CO_2 on electricity.[5] This is the highest effective tax rate on carbon among Nordic countries, which all also apply an explicit carbon tax (Figure 3.4). As biomass and biofuels are exempt from the energy tax and account for a large share of energy consumption, the effective tax rate on carbon is zero for nearly half of CO_2 emissions in Sweden, although there is a carbon price on part of these emissions via the EU-ETS (Figure 3.4; Chapter 4). Overall, most of the carbon and energy tax burden falls on the residential, commercial and public service sectors.

This heterogeneity in effective CO_2 tax rates lowers the instrument's cost effectiveness because emission abatements are made in sectors (and for fossil fuels) where tax rates are the highest and not necessarily where marginal abatement costs are the lowest (OECD, 2011). The carbon tax is considered to have contributed to reducing emissions in the residential and service sectors, which now account for a relatively minor share of emissions, and to slowing down emission growth in transport (Chapter 4). Existing low-cost abatement options may not have been sufficiently exploited in the sectors benefiting from favourable tax rates, including industry, mining, agriculture, forestry and shipping.

In 2009, Sweden passed legislation to partially reform energy and CO_2 taxes and gradually reduce exemptions in the period 2010-15 (Table 3.2). Reducing exemptions from the CO_2 tax is expected to increase its cost effectiveness and help moderately reduce emissions to 2030, without entailing major general tax increases or negative economic impact over the long term (NAO, 2012). This is a welcomed step forward, although some exemptions remain that are potentially environmentally harmful. These include the tax exemptions on peat, one of the most carbon-intensive fuels, although most of it is used in sectors covered by the EU-ETS. Continuing to phase out exemptions would result in a more uniform effective tax rate on carbon, which would further improve cost effectiveness. Any competitiveness concern needs to be addressed by means of payments or refunds that are not proportional to the level of energy consumption, enabling incentives for energy savings and emission reductions to be maintained.

Figure 3.4. **Effective tax rates on a carbon-emission basis in Nordic countries as of April 2012**



Note: The horizontal axis shows the proportion of CO_2 emissions from energy use. The vertical axis shows the corresponding effective tax rate on carbon. Tax rates as of 1 April 2012; energy use is based on IEA data for 2009.
Source: Based on OECD (2013), *Taxing Energy Use: A Graphical Analysis*.

Broadening the tax base seems preferable to raising tax rates, which are already high compared to other countries. SEPA (2007) concluded that further increase in the carbon and energy tax rates would have limited effect on long-term CO_2 emissions. The EEA (2011b) partly confirmed this conclusion: an additional tax reform based on energy and carbon taxation is estimated to help reduce Sweden's energy-related CO_2 emissions by 4.5% by 2020, while reducing GDP by about 0.5%. This would be the lowest emission reduction among EU countries.[6] Continued adjustments (at least to inflation) are needed to maintain the incentive function of the taxes, as well as their ability to raise revenue. The rates of the energy and carbon taxes were raised in 2007-09, but have remained unchanged since and are not expected to change again until 2015. Sweden's tax legislation requires that energy and carbon tax rates are regularly adjusted for inflation.

While the carbon tax reflects the externalities linked to CO_2 emissions, the energy tax component is supposed to address other environmental externalities. However, this is not the case. In particular, the energy tax component on diesel for transport vehicles is half of the tax on petrol (Table 3.2), but diesel-fuelled vehicles generate higher levels of NO_x and fine particles than comparable petrol-fuelled vehicles. The higher vehicle tax applied to diesel passenger cars is an inadequate substitute for the reduced fuel tax, as shown by the increasing share of diesel cars in the fleet (Chapter 4). While the energy tax on diesel has been raised in recent years, it should be brought at least to the same level as that of petrol. If diesel-petrol tax parity is achieved, the vehicle tax for diesel cars could be set at the same level as for petrol cars.

Table 3.2. **The 2009 reform of energy and CO_2 taxation**

	2009/10		2011		2013		2015	
	CO_2 tax	Energy tax	CO_2 tax	Energy tax	CO_2 tax	Energy tax	CO_2 tax	Energy tax
Transport fuels								
Petrol	1.05/kg	0.34/kWh (3.08/l)	1.05/kg	0.34/kWh (3.08/l)	1.05/kg	0.34/kWh (3.08/l)	1.05/kg	0.34/kWh (3.08/l)
Diesel	1.05/kg	Reduced: 0.13/kWh (1.33/l)	1.05/kg	Reduced: 0.15/kWh (1.53/l)	1.05/kg	Reduced: 0.17/kWh (1.73/l)	1.05/kg	Reduced: 0.17/kWh (1.73/l)
Diesel in work machinery within the agriculture and forestry industries, etc.	Refund 2.38/l	Reduced: 0.13/kWh (1.33/l)	Refund 2.10/l	Reduced: 0.15/kWh (1.53/l)	Refund 1.70/l	Reduced: 0.17/kWh (1.73/l)	Refund 0.90/l	Reduced: 0.17/kWh (1.73/l)
Diesel in certain industrial mining activities	Reduced: 1.05/kg x 21%	Exempt	Reduced: 1.05/kg x 30%	Reduced: 0.024/kWh	Reduced: 1.05/kg x 30%	Reduced: 0.024/kWh	Reduced: 1.05/kg x 60%	Reduced: 0.024/kWh
Natural gas and LPG	Reduced: 1.05/kg x 59% (natural gas); 1.05/kg x 52% (LPG)	Exempt	Reduced: 1.05/kg x 70%	Exempt	Reduced: 1.05/kg x 80%	Exempt	1.05/kg	Exempt
Biofuels for stationary and transport use	Not applicable	Exempt	Not applicable	Exempt	Not applicable	Exempt	Not applicable	Exempt
Fossil fuels for stationary purposes								
Outside the EU-ETS								
Households and services	1.05/kg	0.01-0.08/kWh	1.05/kg	0.08/kWh	As in 2011		1.05/kg	0.08/kWh
Industry, agriculture, forestry and aquaculture	Reduced: 1.05/kg x 21%	Exempt	Reduced: 1.05/kg x 30%	Reduced: 0.0024/kWh	As in 2011		Reduced: 1.05/kg x 60%	Reduced: 0.0024/kWh
Within the EU-ETS								
Industry	Reduced: 1.05/kg x 15%	Exempt	Exempt	Reduced: 0.0024/kWh	As in 2011		Exempt	Reduced: 0.0024/kWh
Combined heat and power (CHP) production	Reduced: 1.05/kg x 15%	Exempt	Reduced: 1.05/kg x 7%	Reduced: 0.0024/kWh	As in 2011		Reduced: 1.05/kg x 7%	Reduced: 0.0024/kWh
Other heat production	Reduced: 1.05/kg x 94%	0.01-0.08/kWh	Reduced: 1.05/kg x 94%	0.08/kWh	As in 2011		Reduced: 1.05/kg x 94%	0.08/kWh

Note: Tax rates at 2009 prices.
Source: NAO (2012), *Climate-related taxes: Who pays?*, Swedish National Audit Office.

1.2. Transport-related taxes and charges

Revenue from transport-related taxes and charges has increased since 2000, especially with the introduction of the congestion charge (see below) and the tax on traffic insurance (Figure 3.1). Vehicle taxes accounted for 17% of tax revenue from environmentally related taxes in 2012, up from 12% in 2000. Vehicle taxes play, nonetheless, a lower role in Sweden than in most other OECD member countries (Figure 3.2). Sweden is one of the few European countries that do not apply a tax on vehicle purchase or registration. Instead, an annual motor vehicle tax has long been in place.

Until 2006, the motor vehicle tax was based on vehicles' weight and fuel used, with higher rates for diesel-powered vehicles. The tax was restructured and based on CO_2 emissions of passenger cars in 2006, and of light duty vehicles in 2011. The tax comprises a basic fixed amount and an additional component based on CO_2 efficiency.[7] Tax exemptions apply to cars that are particularly CO_2-efficient.[8] In line with recommended practice, the CO_2 component of the tax is not differentiated according to fuel type, but the base rate is three times higher for diesel cars than for petrol cars. This aims to offset the lower energy tax rate on diesel and to take into account the higher impact on local air pollution of diesel vehicles (Section 1.1). The annual tax on heavy goods vehicles, which is relatively lower than the tax on passenger cars, depends on various factors, including type of fuel used, axes, weight and EU environmental classification.

Taxes on vehicle ownership are theoretically less efficient than fuel taxes and road charges in reducing GHG and air pollutant emissions since they are more removed from actual vehicle use. Yet the CO_2-based differentiation of vehicle taxation can provide car owners with an incentive to choose low CO_2-emission vehicles, thereby affecting fleet composition. The average CO_2 emissions from new cars sold in Sweden has decreased by 28% since the restructuring of the vehicle tax in 2006, although it remains slightly above the EU average (Figure 4.11; Chapter 4).

However, the implicit incentive provided by Sweden's vehicle taxation also appears to be relatively weak. The CO_2-related component accounts for a relatively low share of the vehicle tax, and the tax differential across vehicle categories is one of the lowest among European countries that also apply a CO_2-based vehicle tax (Kalinowska et al., 2009). This could be addressed by complementing the annual tax with a moderate registration or purchase tax also based on CO_2-emission performance. Although not conclusive, empirical evidence suggests that retail prices affect car purchases more than lifetime costs, implying that vehicle registration taxes are more effective in reducing the average CO_2 emissions of new cars than annual circulation taxes (Vance and Mehlin, 2009). Vehicles registered before the tax reform remain subject to the old annual tax, which may also undermine the incentive to change cars.

The municipalities of Stockholm and Gothenburg introduced a congestion charge (in 2007 and 2013, respectively).[9] The charge also has a fiscal purpose since most of the revenue is intended to finance investment in public transport. The congestion charge has contributed to reducing Stockholm city centre traffic by an average 20% (Börjesson et al., 2012). The congestion charges are the only form of road pricing in Sweden, as passenger cars do not pay road tolls on the national road network. Heavy goods vehicles pay an annual road charge that varies with the size and environmental classification of the vehicle, but not with distance driven. Introducing distance- and emission-based road tolls for heavy goods vehicles could help mitigate GHG emissions from freight transport, which have increased since 2000 (Chapter 4), as well as other environmental externalities.

SEPA (2007) concluded that an overall evaluation of economic instruments in the transport sector is necessary. This conclusion is still valid: it is important to assess the interactions among motor fuel taxes, the CO_2-differentiated vehicle tax and other taxes, as well as instruments that run counter to environmental objectives, such as company car taxation and commuting allowances (Section 2.2).

1.3. Other taxes and charges

Sweden applies several taxes and levies on pollution and resource use. The modest revenue from these taxes represented a little over 1% of revenue from environmentally related taxes in 2012.

Taxes and charges on SO_x and NO_x emissions

A sulphur tax completes the excise duties of energy products. Introduced together with the carbon tax, it is levied on the fuels with the highest sulphur content. Revenue from this tax has declined considerably (in 2012 it was about one-third of its 2000 level), mainly because of the shift to lower-sulphur fuels the tax stimulated, but also because tax rates have remained unchanged since the introduction of the tax.[10]

Sweden introduced a charge on NO_x emissions from stationary combustion facilities in 1992 to complement emission limits. The charge aimed primarily to provide incentives to reduce emissions beyond the limits, thereby combating acidification. The scope of the charge was progressively extended to cover a larger number of combustion plants.[11] All proceeds from the charge are paid back to the plants based on the amount of energy used in order to reduce any potentially negative impact on competitiveness of regulated plants. This means that plants with low emissions vis-à-vis energy production are net receivers of funds, while plants with high emissions in relation to energy production are net payers (OECD, 2013b).

The NO_x charge has encouraged regulated facilities to lower their emission intensities well below the emission standards. It has also stimulated demand for new NO_x abatement technologies and innovation (Section 4). Since the introduction of the charge, NO_x emissions per unit of energy produced were more than halved (OECD, 2013b). However, there is a need to systematically adjust the tax rate to maintain the tax incentive: the charge was originally set at SEK 40/kg of NO_x emitted, and was raised only in 2009 to 50 SEK/kg. Due to the refund mechanism, industry has faced hardly any net cost increase. The refund mechanism gives rise to an implicit subsidy to producers; they do not pay the full environmental cost of the pollution they generate. This distorts the allocation of economic resources in favour of polluting activities, while cleaner options may be available (OECD, 2013b).

Taxes on raw materials

Sweden is one of the few countries that impose taxes on certain raw materials. In the mid-1990s, it introduced a tax on natural gravel to encourage material substitution and conservation of a scarce resource, as well as to recognise the role of natural gravel in preserving water quality.[12] The tax increased the price of natural gravel by about 10%, nearly closing the price gap between gravel and its closest substitute, crushed rock. The tax was successively raised to maintain its incentive function, reaching SEK 13/tonne of gravel, but it remains considerably lower than the tax rate applied in the United Kingdom. Regional variation in gravel scarcity is not reflected in the tax, which penalises the North where gravel is not scarce. Extraction and use of natural gravel have substantially declined over the last two decades, while use of substituted and recycled materials has increased. Factors other than the gravel tax played a role, including stricter permitting requirements for quarries and increasing demand for different, high quality materials in the construction sector. Hence, the cost effectiveness of the tax is not clear (EEA, 2008; Söderholm, 2011).

Waste management

In 2000, Sweden introduced a tax on waste disposed of in a landfill facility. Since its introduction, the landfill tax rate has risen 74%, reaching SEK 435/tonne. In 2006, Sweden introduced a tax on incineration of waste, which was removed in 2010; the tax, which also aimed to encourage material recycling, was the highest for incineration without energy recovery and decreased with the level of energy recovery (Lindhjem et al., 2009). In combination with other policy measures, these taxes have helped divert municipal waste from landfills and increase waste recovery and incineration with energy recovery (Chapter 1). However, the removal of the incineration tax in 2010 may have reduced the incentive to sort waste for recycling (Section 3.6). A number of other levies are

implemented in the waste sector, including charges on packaging materials, nickel-cadmium batteries and car tyres, as well as deposit-refund systems for aluminium cans and plastic bottles.

Water and sea pollution

Wastewater pollution charges, calculated as a function of effluent loads, can be imposed on industrial water users. However, no charge can apply to agriculture because landowners have the right to use groundwater resources underneath their property (Speck et al., 2006). A tax on pesticides (SEK 30/kg of active substance) has been in place for 30 years to help reduce the use of pesticides and the associated health and environmental risks. A tax on mineral fertilisers containing nitrogen and phosphorus helped reduce leaching by an estimated 1 300 to 1 800 tonnes of nitrogen per year (Lindhjem et al., 2009), but the tax was removed in 2010 (Chapter 5). There is scope to extend the use of economic instruments to improve water quality through, for example, reducing discharges of nitrogen and phosphorus from agriculture, husbandry and wastewater treatment plants.

Sweden also introduced economic incentives to reduce sea pollution from ships (Chapter 5). A pollution charge applies to oil spills; it is based on the discharged amount and the size of the vessel, and is intended to work as a deterrent. Since 2004, shipping lane duties have been differentiated on the basis of bunker fuel sulphur content and of NO_x emissions from ships. The Swedish Maritime Administration estimates that these differentiated shipping lane duties have contributed to accelerating the introduction of nitrogen removal equipment on board ship (Lindhjem et al., 2009).

2. Removing environmentally perverse incentives

As in other countries, Sweden provides a number of subsidies that could be harmful for the environment. These subsidies, in the form of direct support or preferential tax treatment, exist primarily in the energy, transport, agriculture and fishing sectors. SEPA (2012a) estimated that potentially environmentally harmful subsidies and tax expenditures amounted to about SEK 48 billion in 2010, or about 1.4% of GDP. The transport sector accounted for 52% of these subsidies, followed by the energy sector (43%) and the agriculture and fishing sectors. Income support for agriculture is largely decoupled from output or input use, but agriculture benefits from fuel subsidies. In the energy and transport sectors, most of the subsidies are provided implicitly through tax reductions (Section 2.1). In general, such subsidies contravene the polluter-pays and user-pays principles, distort competition, lock in inefficient technology and lead to inefficient allocation of resources. Subsidies weigh on current public finances, and can entail additional future expenditure to remediate the potential environmental and health damage. The cost effectiveness of Sweden's environmental policy would benefit from the reform of these support measures.

While both SEPA and Statistics Sweden conducted some studies, there is no systematic, consistent and comprehensive analysis of environmentally harmful subsidies. The government reviews tax expenditures annually, but the reports do not assess the potential environmental impact of subsidies. As recommended to other OECD member countries, Sweden could build on the annual reporting of tax expenditures to establish a process for the systematic review of environmentally harmful subsidies. In addition, Sweden should consider introducing a mechanism to screen new subsidy proposals (and removals) against their potential environmental impact, the effect on public finances and,

more generally, economic and social costs and benefits. This would further improve the transparency of the tax and public expenditure system and could be the basis for subsequent reforms of subsidies and special tax treatment that are not justified on economic, social and environmental grounds.

2.1. Tax concessions on energy use

As Section 1.1 discusses, Sweden has made progress in removing exemptions from the energy and CO_2 taxes. Other exemptions and differentiated tax treatments still apply, however (Table 3.3). The favourable tax treatment of diesel used in transport is the largest tax expenditure, estimated at SEK 11.3 billion or EUR 1.2 billion in 2011 (OECD, 2013c). Other tax expenditures include exemptions and reduced rates for fuels used in agriculture, fishing, forestry, mining, industry outside the EU-ETS, domestic shipping and aviation. Table 3.3 presents the consumer support implicit in the main tax expenditures for fossil fuels in Sweden, as estimated by the OECD (2013c).

Table 3.3. **Selected tax expenditures for fossil fuel consumption in 2011**

Tax expenditure	Fuel	SEK million[a]
Reduced energy-tax rate for diesel used in transport	Petroleum	11 300
Energy tax exemption for domestic aviation	Petroleum	930
CO_2-tax exemption for domestic aviation	Petroleum	860
Energy-tax exemption for domestic shipping	Petroleum	560
CO_2-tax exemption for domestic shipping	Petroleum	500
CO_2-tax reduction for diesel used in agriculture and forestry	Petroleum	1 230
Reduced energy-tax rate on diesel for the mining industry	Petroleum	120
Reduced CO_2-tax rate for diesel used by the mining industry	Petroleum	190
CO_2-tax exemption for peat[b]	Coal[c]	1 840
Reduced energy-tax rate on heating fuels for industrial consumers	Natural gas	323
	Coal	333
Reduced CO_2-tax rate for industrial consumers outside EU-ETS	Natural gas	380
	Coal	392

a) Preliminary 2011 data.
b) 2010 data. In Sweden, nearly all peat is consumed in heat and power plants, which fall within the scope of the EU-ETS.
c) Swedish authorities define peat as "slowly renewable biomass". The guidelines of the Intergovernmental Panel on Climate Change classify peat neither as fossil fuel nor as biomass, but specify that its GHG emission characteristics are comparable to that of fossil fuels; CO_2 emissions from combustion of peat are, therefore, included in national emissions as for fossil fuels.
Source: OECD (2013), *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013*.

Protecting industrial competitiveness has traditionally been the main justification for these subsidies. However, many of these exemptions remain unjustifiable on economic grounds and should be phased out. Such tax benefits reduce energy prices, thereby encouraging energy use and reducing incentives to adopt energy-efficient technology, with negative implications for GHG emissions. Also, they distort competition among energy sources and can favour the use of dirtier fuels. Tax breaks should only be used to avoid double taxation/pricing. If needed to preserve industry competitiveness, the tax benefits could be replaced by better targeted public support, ideally linked to energy savings.

In addition, Statistics Sweden estimated that fully auctioning the allowances under the EU-ETS would generate revenue for the public budget of between SEK 2 and 6 billion.

The fact that allowances have been given for free is, therefore, considered an implicit subsidy of equal amount (SCB, 2010).

Sweden has promoted the use of biofuels through exemptions from the energy and CO_2 tax. This has led to dramatic growth in biofuel consumption and helped reduce GHG emissions from road transport (Chapter 4). However, the cost of abating a tonne of CO_2 through biofuels is considerably higher than that of other abatement measures. The tax revenue loss alone costs SEK 2 billion per year, or SEK 3 000 per tonne of CO_2 abated. In addition, according to NAO (2011), the tax exemption has not helped bring forward new, advanced biofuels. Instead, it has favoured low blends, for which the market is well established. In a welcomed move, the government decided to remove the energy tax exemption for low-blended biofuels and introduce a quota system as from mid-2014 (Chapter 4). This is estimated to save the public budget about SEK 0.6 billion per year in 2014-17. Yet Sweden should evaluate the full costs and benefits of the tax exemption for biofuels with a view to avoiding any overcompensation.

2.2. Company car taxation

Like many other countries, Sweden applies a favourable taxation to the benefits deriving from the personal use of company cars, although less favourable than elsewhere. According to an OECD study, the Swedish tax system captures about 70% of the benchmark benefits (Harding, 2014). This share is higher than in a number of countries such as France and Germany, but it is lower than in other Nordic countries (the Norwegian tax system, for example, captures nearly 100% of the benefits). This is because company cars used for private purpose only increase an employee's taxable income by between 9% and 20%, depending on the car's price. Reduced rates apply to low-emission vehicles such as electric or electric/hybrid cars. However, Sweden is among the few OECD countries to fully take account of the fuel costs paid by employers in calculating the employee's tax base. As a result, employees are encouraged to choose more fuel-efficient cars and to limit the use of company cars. Nonetheless, this tax treatment results in an annual subsidy of EUR 1 446 per company car, which is in line with the average subsidy across the 27 countries examined in the OECD study. Therefore, it is attractive for employees to be paid part of their salary in the form of cars: 48% of newly registered cars in 2009-11 were company cars (Harding, 2014). On average, in the same period, newly registered company cars emitted more CO_2 per km (164g CO_2/km) than the average car (159g CO_2/km).

Employees travelling to work benefit from a tax deduction to compensate for commuting expenses. Sweden provides less favourable treatment for car use than for other forms of commuting, with the intention of promoting the use of public transport. A per-kilometre allowance[13] for car use and carpooling is applied for commuting costs in excess of a threshold, while public transport costs in excess of this threshold are fully tax deductible (Harding, 2014). However, the per-kilometre deduction, combined with the thresholds, can encourage workers to live further away from their place of work and increase distance travelled. Employer-paid public transport costs and parking lots are correctly treated as fully taxable items of an employee's income, which leaves the employee neutral in choosing between commuting options.

The tax treatment of company cars and the commuting allowance represent a cost for the public budget. Sweden's revenue loss attributable to the tax treatment of company cars is estimated at EUR 0.6 billion in 2012 (Harding, 2014), or 0.15% of GDP. From an environmental perspective, these measures tend to encourage private car use, long-distance commuting

and urban sprawl. They can result in increased fuel consumption and GHG emissions, as well as higher emissions of local air pollutants and greater noise, congestion and risk of accidents. OECD (2013d) estimated the average environmental impact of undertaxation of company cars is EUR 112 billion per year in OECD member countries.

3. Investing in the environment to promote economic growth

3.1. Environmentally motivated subsidies

Sweden provides a number of direct subsidies to support and stimulate environment-related investment. In 2012, these subsidies accounted for 0.12% of GDP, a decline from 0.2% of GDP in 2000.[14] Most of these subsidies support management of environmental resources (Table 3.4). Of this category, the vast majority is allocated to agri-environmental measures within the rural development programme (RDP) and the EU Common Agricultural Policy.

Overall, the RDP funds amounted to nearly EUR 4 million in 2007-13, 70% of which were allocated to agri-environmental measures (e.g. for biodiversity protection, soil and water quality). There is some evidence that the farm areas receiving these payments have better environmental records than those not receiving them, such as reduced pesticide use and nutrient leaching. However, differences are small. A wide range of agri-environmental payments often overlap. There is a need to streamline the system, target support to areas with specific environmental needs and link payments to measurable environmental outcomes (Swedish University of Natural Sciences, 2010).

Sweden has also implemented several support programmes to promote renewable energy sources and energy efficiency, as well as to help mitigate GHG emissions (Chapter 4, Section 3.3). Within declining total environmentally related subsidies (as a share of GDP), the role of energy- and climate-related subsidies increased from 23% to 27% of total environmentally related subsidies between 2000 and 2012 (Table 3.4). There has been an increasing focus on research and development (R&D) activities (Section 4), which accounted for more than half of energy- and climate-related subsidies in 2012. This is a welcomed development, as targeted R&D subsidies are, in principle, more efficient in stimulating innovation than other investment subsidies.

Table 3.4. **Environmentally motivated direct subsidies in 2012**

Sector	Million SEK	%
Resource-related subsidies, *of which:*	3 272	72.3
Environmental supports in agriculture	2 506	55.4
Support for the environment in the sea	125	2.8
Energy- and climate-related subsidies, *of which:*	1 235	27.3
Energy research	662	14.6
Support for more efficient use of energy	110	2.4
Support for energy technology/energy efficiency	395	8.7
Different supports in the climate area	54	1.2
Transport-related subsidies	20	0.4
Eco-car subsidy	20	0.4
Total	4 527	100.0

Source: Statistics Sweden (2014), *System of Environmental and Economic Accounts* (database).

Overall, these environmental subsidy programmes have encouraged businesses and households to make environment-friendly investments such as in the area of energy efficiency and renewables (Chapter 4). They do this mainly by lowering upfront costs and making the "greener" investment economically viable. However, there is no comprehensive evaluation of their cost-effectiveness, and the benefits of these support mechanisms are unclear (Growth Analysis, 2012a).

In addition to being a cost to the budget, subsidies are generally not the most cost-effective instrument to achieve environmental objectives: many beneficiaries would make the investment even without the support. As determining the exact subsidy amount needed to stimulate changes in investment decisions is difficult, subsidy programmes may result in extensive windfall benefits. In addition, by targeting a limited range of "cleaner" technologies or activities, subsidy-based measures encourage firms and consumers to adopt the subsidised solutions even when other options would be more effective. Therefore, they tend to generate technology lock-in. Finally, as subsidies make the supported activity cheaper, they may perversely increase activity levels and, therefore, use of energy and natural resources and pollution (rebound effect) (OECD, 2012a).

3.2. Environment-related components of the fiscal stimulus packages

Responding to the 2008/09 economic crisis, Sweden introduced discretionary measures in 2009-11 amounting to about 2.8% of 2008 GDP (OECD, 2009a). As Sweden entered the crisis with a strong fiscal position, the fiscal stimulus did not lead to debt running out of control (OECD, 2011). Environment-related measures were estimated at 5-6% of the total package, or 0.2% of GDP (Pollitt, 2011). The majority of green measures were geared towards the support and commercialisation of research and development (R&D) to sustain growth in the Swedish automotive industry. Support for developing biofuels, batteries, electric cars and similar measures made up two-thirds of the total (Table 3.5). Other measures included the expansion of the energy-efficiency programme and targeted R&D support for commercialisation of green technologies, such as biogas and solar cells. It is difficult to establish the additionality of the green elements in the stimulus package as it is often not possible to distinguish it from a business-as-usual budget. For example, some measures that were part of the stimulus package were also included in programmes related to energy, environment and climate change.

Table 3.5. **Environment-related components of the fiscal stimulus packages**

Measure	Description	Budget
Biofuels	Funds that support pilot and demonstration projects for second-generation biofuels.	SEK 875 million (2009-11)
Green technologies	Creation of a venture capital company emphasising green technology in the automotive industry.	SEK 3 billion
Batteries for vehicles	Support to developing battery techniques in electric vehicles.	SEK 85 million
Energy efficiency	A package of measures to improve energy efficiency in different sectors.	SEK 300 million/year (2010-14) SEK 255 million (2012)
Commercialisation of green technologies	A multi-year aid package to encourage commercialisation of green technologies.	SEK 339 million (2009-11)
Total		SEK 6 billion (maximum)

Source: Pollitt, H. (2011), *Assessing the Implementation and Impact of Green Elements of Member States' National Recovery Plans*.

3.3. Investment in renewables and energy efficiency

The adoption of the 2008/09 integrated energy and climate policy significantly increased investment to expand the use of renewables for electricity generation, heating and cooling, and transport (Chapter 4). Energy supply from renewable sources has grown by 18% since 2000 due to the growing use of biofuels and waste in electricity, heat production and the increase in electricity production from wind. Sweden has surpassed its 49% renewables target set under the Renewable Energy Directive by reaching 51% of gross final energy consumption sourced by renewables in 2012 (Chapter 1).

A tradable electricity certificate (TREC) system introduced in 2003 drove the deployment of renewables in electricity (mainly biofuel-based electricity production in combined heat and power [CHP] systems and wind) (Chapter 4. In addition, investment subsidies have been granted to wind, solar PV and biogas for transport. Local investment programmes (LIP, KLIMP, Sustainable Cities) have also stimulated rapid expansion of the district heating network and of CHP installed capacity. Although they have been criticised for poor cost effectiveness, subsidies may have brought forward these investments, or ensured they had higher environmental standards. In 2012, the government phased out some investment subsidies to existing technologies (e.g. for wind power), instead strengthening measures for the development of new technology. Targeted research, development and demonstration (RD&D) policy for specific renewable technologies has made Sweden a leader in clean energy technologies such as second-generation biofuels and smart grids (Section 4).

Targeted R&D, along with energy and CO_2 taxes and emission trading, are part of Sweden's comprehensive package of measures to promote energy efficiency (Chapter 4). Around SEK 530 million (EUR 61 million) per year is allocated from the state budget for energy efficiency. Half of it goes to the energy efficiency programme (2010-14) to support regional and local climate policy initiatives, green public procurement and energy management, energy audit and procurement of energy-efficient technologies in small and medium-sized enterprises. Under the programme for improving energy efficiency in energy-intensive industry, participating companies invested SEK 708 million in energy efficiency measures over 2005-09 and saved 1.45 terrawatt-hours (TWh) of electricity in 2004-08 compared to projections. Overall, Sweden expects to achieve 15% energy savings by 2016, thereby exceeding the target set by the Energy Services Directive but more effort is required to achieve the energy intensity target for 2020 (Chapter 4).

3.4. Investment in transport

With a nearly 60% increase in real terms since 2000, investment in inland transport infrastructure grew much faster in Sweden than in the average of Western European countries (+2%). Between 2000 and 2009, transport investment rose from 0.6% of GDP to 1%, and then declined to 0.8% in 2011, a level comparable to the OECD average. During the same nine-year period, the share of investment in rail infrastructure increased steadily from around 39% of total investment in inland transport infrastructure to 46% and then decreased to 43% in 2011. As in other Western European countries, this trend reflects the political commitment to development of railways (ITF, 2013). Following Sweden's commitment for a fossil-fuel independent vehicle fleet by 2030, the demonstration and deployment of electric vehicles and buses running on biogas in Swedish cities progressed. Large investments are being made in maintenance and creation of new bicycle infrastructure (IEA, 2013).

However, recent OECD analysis shows that efficiency of the road transport system is low in Sweden, partly related to an overextended network (OECD, 2012b). Punctuality is perceived as a major rail performance issue and rail capacity faces infrastructure bottlenecks in many regions (ITF, 2013). Insufficient availability of rail services has hampered shifting from road to rail. A recent report (Fiscal Policy Council, 2013) pointed out three major issues in the Swedish transport sector. First, below-cost pricing for the use of existing infrastructure results in excessive demand and congestion, an artificially high need for investment to remove bottlenecks and suboptimal business localisation. Second, a number of investments in new transport infrastructure (e.g. the Bothnia line and the Gothenburg package) are not economically profitable. Third, the lack of cost monitoring does not allow policy makers to judge whether the resources allocated are used effectively. Further, transport infrastructure planning conflicts with climate objectives as the profitability of many infrastructure projects assumes increasing traffic volumes (Chapter 4). The National Audit Office recommended that the government establish an approximate trajectory for reduced transport emissions consistent with climate objectives, and report to Parliament on the division between modes of transport in the long-term infrastructure plan.

3.5. Expenditure for environmental protection

Although very active in international works on environmental accounting, Sweden does not publish regular complete information on public expenditure on environmental protection: expenditure on wastewater management is missing. The latest available data, dating back to the mid-2000s, estimate public spending at about 0.8% of GDP, a share that seems to have remained stable since the early 1990s (SCB, 2005; OECD, 2007). As in other European countries, municipal waste and wastewater treatment account for more than half of environmental expenditure, which is mostly incurred by municipalities.

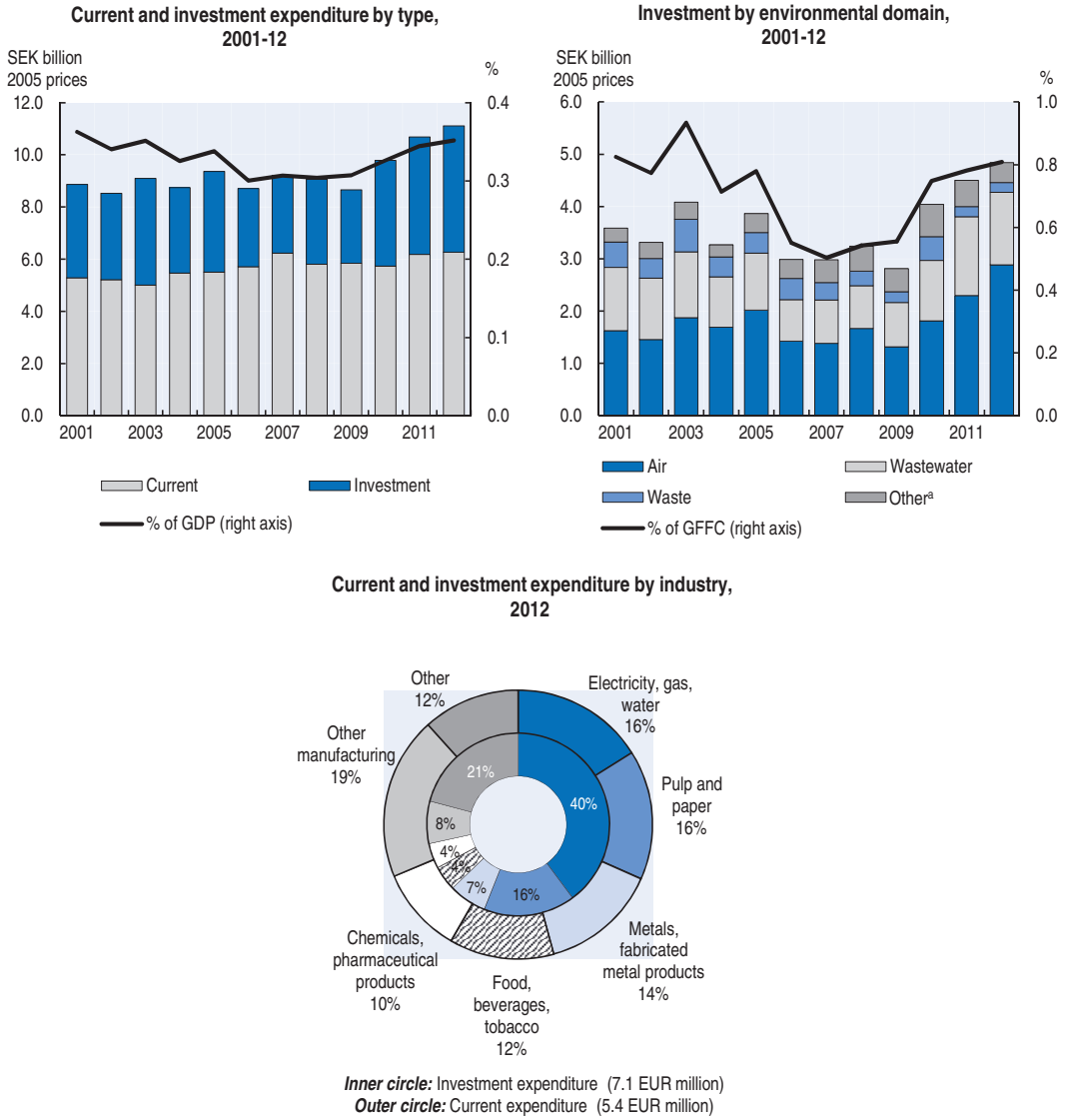
In 2012, Swedish industry[15] spent SEK 12.5 billion for environmental protection or about 0.4% of GDP,[16] on par with the average in European countries (Figure 3.5). This expenditure remained broadly stable in real terms over 2001-08, but significantly increased after 2009 driven by investment in air and climate protection and wastewater treatment. In 2012, electricity, gas and water supply, and pulp and paper industries contributed more than 40% of environmental protection expenditure by industry and more than half of the related investment. Environmental protection accounted respectively for 5% and 11% of total investment in these sectors.

Among the various measures that support Sweden's climate and energy policy (see Table 4.2 in Chapter 4), it is difficult to single out the particular instrument that stimulated the most environmental investment in industry. Löfgren et al. (2013) found that, over 2000-08, GHG-reducing investments have been primarily driven by company characteristics such as energy intensity of the production process and earlier investment in green R&D, rather than by participation in the EU emission trading system (EU-ETS) (Chapter 4).

3.6. Water and waste infrastructures and services

Sweden has a well-developed drinking water and wastewater infrastructure. However, it is a major challenge to cover the related cost of maintenance and renewal while complying with more stringent environmental standards (Mattisson and Mattisson, 2010). Municipalities are responsible for the provision of water and wastewater services. Municipally owned corporations are the most common form of organisation and private participation is limited. In 2006, municipalities were granted the right to provide services

Figure 3.5. **Environmental protection expenditure by industry**



Note: Industry: mining, manufacturing, electricity, gas and water supply.
a) Soil and groundwater, biodiversity and landscape, noise.
Source: OECD (2013), *OECD Economic Outlook No. 93* (database); SCB (2014), *Environmental Protection Expenditure* (database).

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outside their own geographical area with a view to developing economies of scale through inter-municipal co-operation. It is expected this change will increase private participation and competition in the sector.

The provision of water and wastewater services is normally financed by charges, but tax subsidy is allowed. By law, charges are based on actual costs, and thus depend on the level of investments and maintenance, as well as geographical conditions, within a municipality. Charging normally consists of two components: a fixed part related to water and wastewater plant operations and a variable part depending on consumption (almost all consumers have water meters). There are large variations in the price, depending on individual municipalities and type of dwelling.[17] According to Swedish Waters, the overall

water and sewage fee covers 99% of the costs for the whole country. The rest is covered by taxes. In 2011, like other European countries, Sweden was asked to recover costs of all water services[18] in line with the Water Framework Directive (European Commission, 2011). The Commission pointed out that contribution to cost recovery of water services is not disaggregated into different water uses (households, agriculture and industry) (European Commission, 2012a). This makes cross-subsidies among different sectors invisible and hinders the implementation of the user-pays and polluter-pays principles. It also recommended that Sweden integrate environmental and resource costs into its cost-assessment methodology.

Sweden has established an effective waste management system. In the 2000s, various measures have resulted in diverting municipal waste from landfill and increasing waste recovery; to that end, landfill bans and tax and producer responsibility schemes have played an important role (Chapter 1). However, the impact of these measures on waste prevention is unclear and the decline in municipal waste generation in the wake of the economic crisis is expected to be short term. In combination with the energy and CO_2 tax system and climate subsidy programmes[19] (Chapter 4), the waste policy has resulted in increasing the share of incineration with energy recovery[20] and, to a lesser extent, biological treatment (mainly anaerobic digestion). Capacity of energy recovery from waste has more than doubled, leaving Sweden with one of the highest rates of incineration per capita in Europe (Profu, 2013). Material recycling, which remains relatively high by European standards, peaked in 2007 and decreased afterwards (European Commission, 2013a).

Municipalities are responsible for municipal waste management except for waste covered by producer responsibility[21] (SEPA, 2012b). Producers are in charge of providing the collection system for these waste streams and meeting recycling targets. Various types of co-operation between municipalities exist, such as within a joint committee or local government federation. About 70% of municipal waste collection is outsourced to private operators (OECD, 2013e). Local councils set the charges for municipal waste collection and producers decide on the product fee. As a rule, waste collection charges cover the total costs for municipal waste management, but deficits can be tax-funded. The fee is often based on one fixed rate for waste collection and one variable fee for waste treatment. Many municipalities introduced voluntary collection of food waste; those who choose a food-waste subscription pay a lower fee than those who choose to deposit mixed waste. The fee is normally volume-based, but 30 of 290 municipalities have introduced weight-based rates (Avfall Sverige, 2013). Although these pay-as-you-throw schemes certainly contributed to increased waste recycling, they may have been less influential than the physical design of the collection systems. Insufficient consideration of waste issues in the physical planning process is one reason for recycling not to be more prevalent (SEPA, 2012b).

Another reason for recycling not to be more prevalent is incineration overcapacity (SEPA, 2012b). Reduction in waste due to the economic downturn combined with the substantial expansion in incineration capacity has resulted in under-utilisation of the capacity of incineration plants; the gap has been filled by increasing waste imports. The removal of the incineration tax in 2010 resulted in increased imports of waste for incineration, particularly from Norway. Although opinions differ on the effect of the incineration tax on recycling (Government Offices of Sweden, 2009), the share of municipal waste recycled and biologically treated was higher than that of incineration when the tax was in place (2006-10) and declined after the tax was removed (Figure 1.5). Sweden needs to carefully assess the environmental and economic impacts of existing projects to further

expand incineration capacity (SEPA, 2012b). The 2012 national waste plan and the European Resource Efficiency Roadmap, which aim at moving waste management up the waste hierarchy, will further reduce amounts available for incineration.[22] The financial sustainability of the system will have to be evaluated in light of development in the European waste market and the inclusion of waste incineration into the third EU-ETS period (IEA, 2012).

4. Promoting eco-innovation

4.1. Innovation in environment-related technology

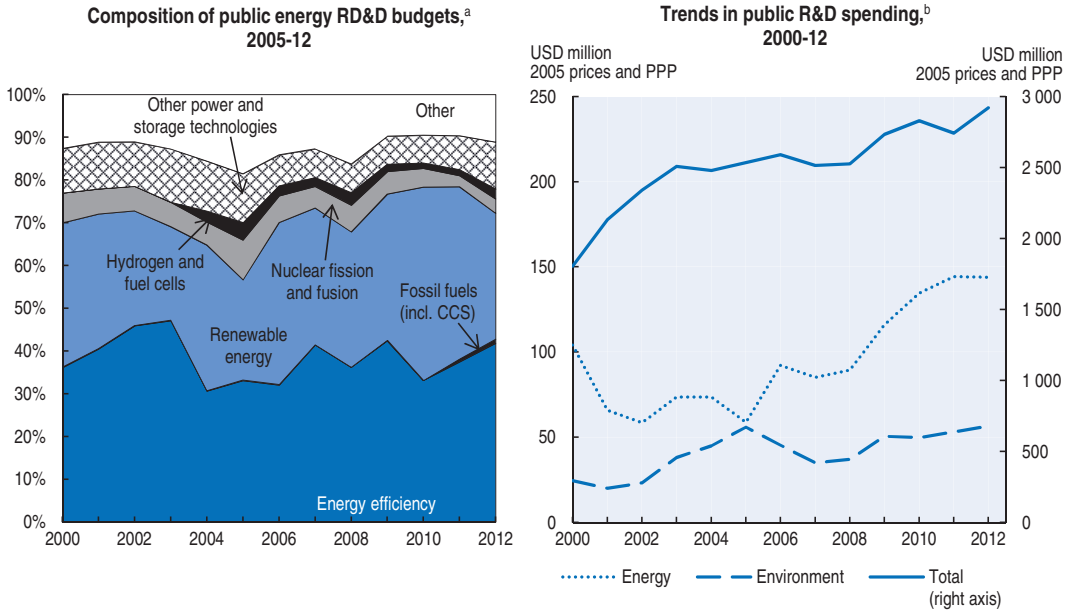
Sweden's innovation performance is one of the best in the world. Innovation has long been a pillar of the country's economic growth (OECD, 2013f). In 2012, gross domestic expenditure on R&D (GERD) represented 3.4% of GDP, the fourth highest rate in the OECD where the average stood at 2.4%. Industry funded 58% of GERD, reflecting Sweden's favourable conditions for business R&D. In 2011, triadic patents per capita and per GDP were the third highest in the OECD.[23] However, Sweden is the only leading country to have decreased R&D intensity over the last decade; this is due to a contraction of business expenditure on R&D from 2.9% to 2.3% of GDP over 2000-12. This trend is linked to an increasing outsourcing of R&D investment by large foreign-owned enterprises to firms outside the country (European Commission, 2013b). Achieving the ambitious national target of 4% by 2020 will be challenging (Regeringskansliet, 2012).[24]

Performance on eco-innovation has improved in the 2000s. Since 2000, total public spending on R&D increased by slightly more than 60%. However, spending on environment-related R&D more than doubled, reaching about 2% of the total in the early 2010s (Figure 3.6). Although this share does not stand out in the OECD, it is underestimated as public environmental research is financed to a significant extent from general university funds. For example, it was estimated that about one-fifth of the Stockholm University research funding, or nearly 1% of total public spending on R&D, was devoted to environmental research in 2009 (Formas, 2011). The 2008 Research and Innovation Bill significantly increased government funding for R&D, in particular on environment and energy, which were identified as strategic areas (Figure 3.6). A breakdown by environmental quality objectives (EQOs) shows that, in 2009, 25% of public spending for R&D on environment and energy was allocated to "Reduced climate impact", 13% to "A good built environment" and about 10% to both "A non-toxic environment" and "A rich diversity of plant and animal life" (Formas, 2011).

Government R&D budgets on energy started to increase steadily following the adoption of the 2006 Energy Research and Development Bill. Between 2005 and 2012, energy spending rose from 2.3% to 4.9% of total public R&D; over 2009-11 increased funding was allocated to demonstration projects for second-generation biofuels. Sweden has emerged as a leader in innovation and research for several clean energy technologies, including second-generation biofuels, smart grids and carbon capture and storage (CCS) (IEA, 2013). Thanks to the strong involvement of the private sector and academia in strategic planning, industry contributions have been increasing since 2009, overtaking government funding. Energy efficiency and renewable energy projects account for more than 70% of energy research, development and demonstration (RD&D) funding.

In 2009-11, Sweden was the third most innovative OECD member country in environment-related technologies in terms of patents per capita and the fourth in terms of

Figure 3.6. **Public R&D spending on energy and environment**



a) Government budgets for Research, Development and Demonstration (RD&D).
b) Government budget appropriations or outlays for R&D; breakdown according to the NABS 2007 classification. Based on data expressed in constant prices. Data exclude public utilities of central government and funding from public research foundations.
Source: IEA (2013), *IEA Energy Technology RD&D Statistics* (database); OECD (2014), *OECD Science, Technology and R&D Statistics* (database).

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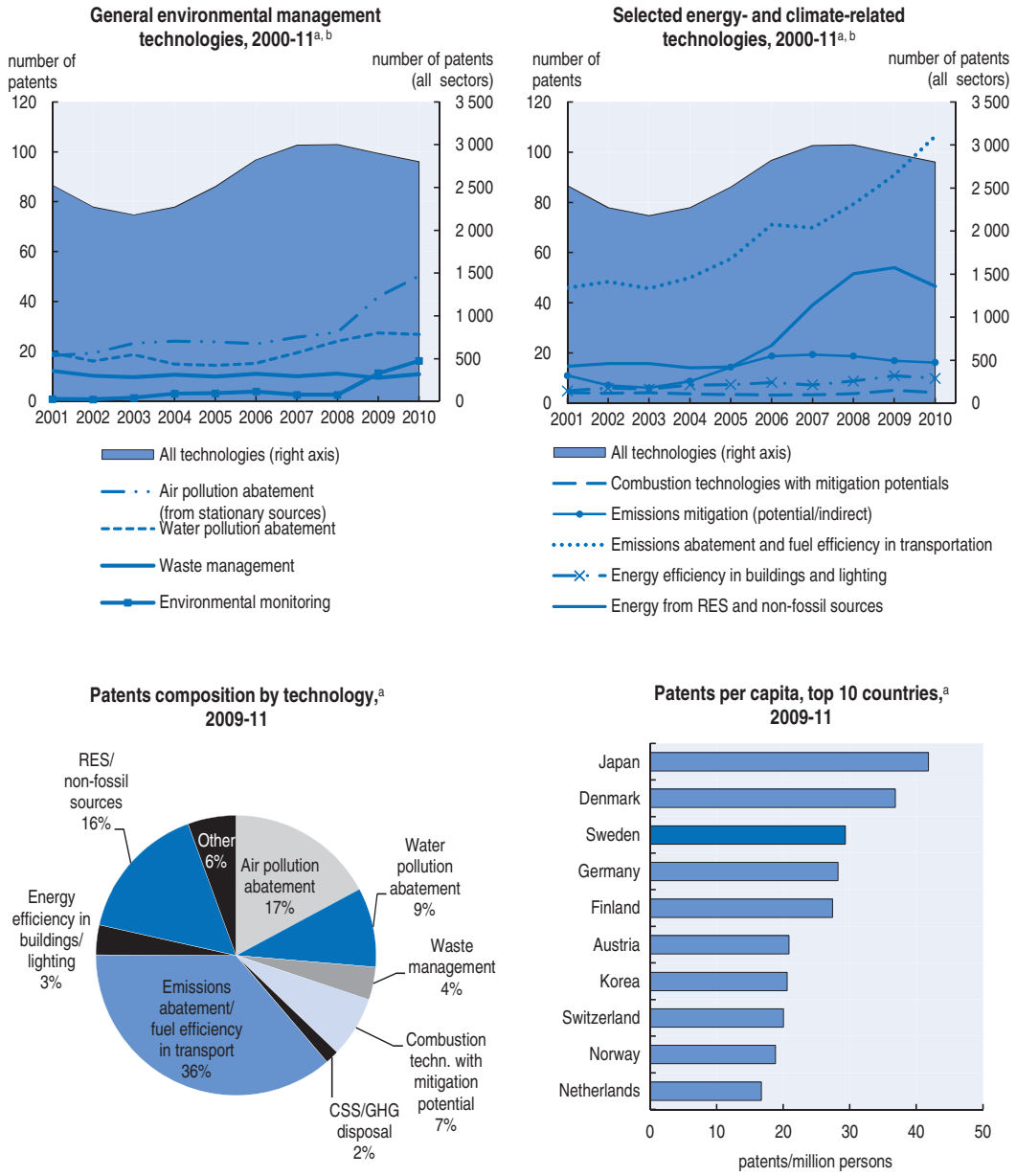
patents per GDP (Figure 3.7). These fields accounted for 10% of overall patent applications associated with inventors located in Sweden, up from 5% in the early 2000s. The largest increases were in air pollution abatement and environmental monitoring, emissions abatement and fuel efficiency in transportation. After a sharp increase between 2006 and 2008, applications for patents in renewable and non-fossil energy dropped significantly. Apart from an overall decline of patent applications following the economic crisis, this trend also reflects increased outsourcing of research and innovation activities. As measured by the revealed technology advantage,[25] Sweden has developed a comparative advantage in technologies related to environmental management and emissions abatement and fuel efficiency in transportation.

However, high R&D inputs have not delivered expected outcomes in terms of growth and jobs. In 2011, turnover in the environmental goods and services sector (EGSS) was estimated at between 2% and 7% of GDP.[26] The sector accounted for 2.2% of total exports and 1.3% of total employment. Although relatively small, the EGSS grew faster than the whole Swedish economy over 2003-11 (Figure 3.8). Management of energy resources, mostly production of renewable energy, accounted for more than half of EGSS turnover, more than one-third of related exports and one-quarter of employment. Out of the 68 000 persons employed in the EGSS, about 16 000 people were working in waste management. While the structure of turnover and employment has remained broadly the same over the period, exports of recycled materials became larger than exports of renewable energies in 2011.[27] The decline in exports of renewable energy in 2010 was due to some activities moving abroad (Growth Analysis, 2012b).

Figure 3.7. **Patent applications in environment-related technologies**



a) Patent applications are based on the priority date and the inventor's country of residence, and use fractional counts on filings under the Patent Co-operation Treaty at international phase (European Patent Office designations).
b) Three-year moving average data.
Source: OECD (2014), *OECD Patent Statistics* (database).

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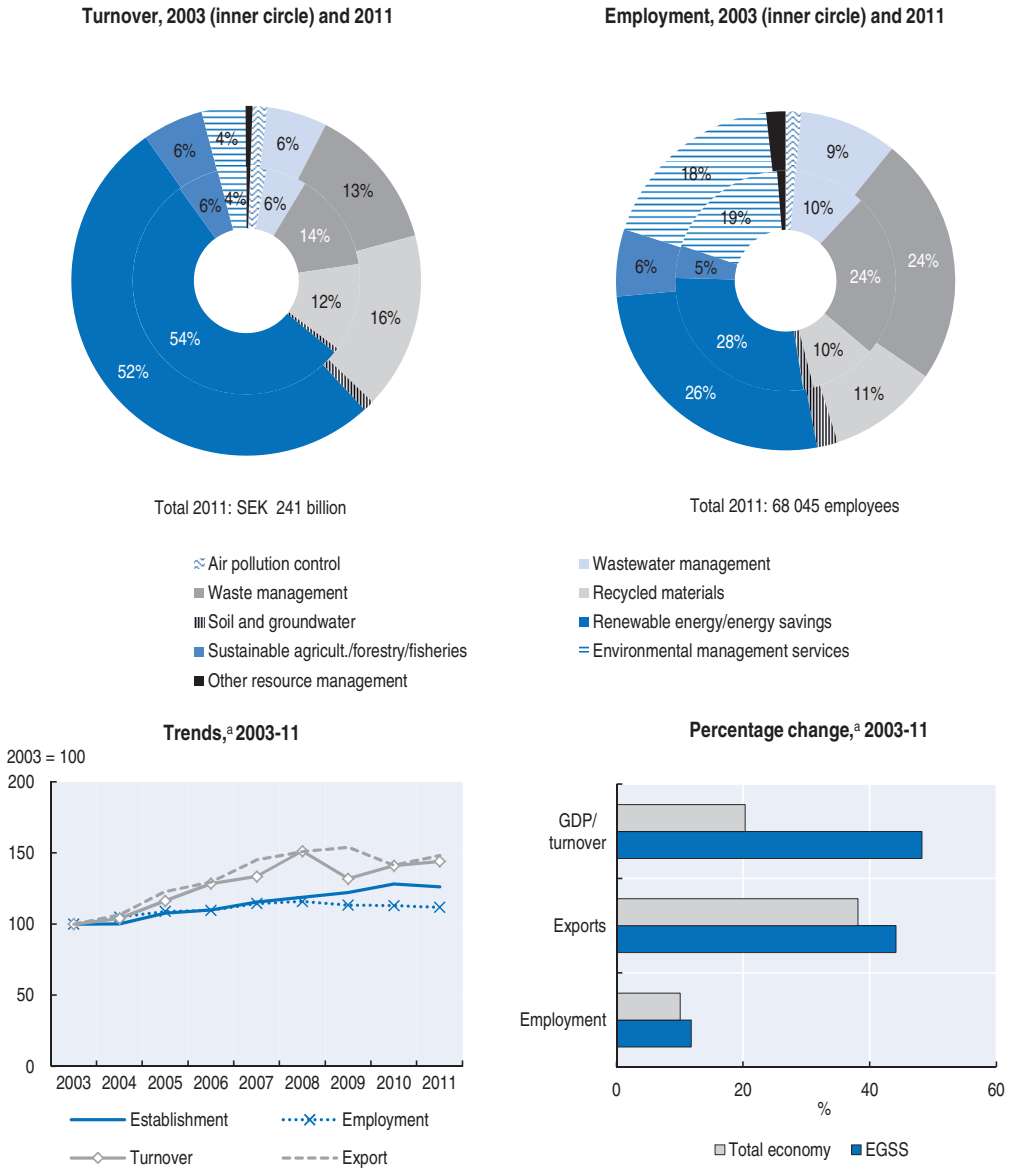
4.2. *Eco-innovation policy framework*

The Ministry of Enterprise, Energy and Communications is responsible for mainstreaming innovation policy. The Ministry of Education and Research is the lead for research (OECD, 2013f). Swedish ministries are small and have many agencies that are large and relatively autonomous. These agencies play a strong role in policy design: they define and develop their specific functions in the innovation system and have their own strategy

Figure 3.8. **The environmental goods and service sector**



Note: The environmental goods and services sector consists of activities that produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air or soil, as well as problems related to waste, noise and eco-systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use. Excludes water supply.
a) GDP, turnover and exports: based on data expressed in constant 2005 prices.
Source: Statistics Sweden (2013), *System of Environmental and Economic Accounts* (database).

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department. They often team up to influence government policies, including for research bills. The Swedish Energy Agency has overall responsibility for implementing energy R&D policy and the National Energy Research Programme. The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), under the Ministry of the Environment, promotes and supports basic and use-oriented research on these issues. The Swedish Government Agency for Innovation Systems (Vinnova) promotes collaboration between companies, universities, research institutes and the public sector. Universities perform most of the environmental research.

Environmental research and technology is funded by many bodies with different roles and mandates: research councils, government innovation agencies and foundations. Among them, Formas, the Foundation for Strategic Environmental Research, the Swedish Energy Agency, Vinnova, the Swedish Research Council, the Swedish Agency for Economic and Regional Growth and Business Sweden[28] are key players (Formas, 2011; Growth Analysis, 2013a). Programmes are often co-managed and co-sponsored by different agencies. This multiplicity of actors reflects the "triple helix" model of Sweden's innovation system, which involves active interplay between government, academy and private enterprise (OECD, 2013f). Although this system allows for flexibility and diversity, it requires significant co-ordination; this makes it difficult to identify the best funding opportunities, particularly for small and medium-sized companies. It also entails a risk of work duplication and suboptimal use of public funds. As recommended by the recent OECD Review of Innovation Policy, Sweden could consider creating "innovation champions" and better streamlining its set of funding programmes. It could build upon competence centres in energy and on its recently established centres of research excellence with an environmental focus in Swedish universities to formulate larger initiatives.[29]

The research and innovation bills, adopted by Parliament every four years, set the priorities for Swedish research and innovation policy. The 2008 bill supported performance-based grant funding of universities and increased public resources in 24 research areas, including ecosystems and natural resources, oceanic environment, climate modelling, sustainable use of natural resources, material science, transport and energy. A programme of new innovation offices in universities helped exploit the research commercially. Additional support was provided to strengthen public-private co-operation and to facilitate access to risk finance. The 2012 bill continues this expansion, allocating an additional SEK 4 billion for 2013-16. The bill emphasises R&D in strategic innovation and in core areas for Swedish industry, such as mining, steel, forest products and biomass, and sustainable urban development. The 2012 Swedish Innovation Strategy to 2020 seeks to adopt a broad innovation concept in designing and implementing innovation policy. Underlining grand societal challenges such as health, food, sustainability and climate, it calls for a dedicated effort to bring innovation policy closer to the centre of policy making and to strengthen horizontal links across governmental work (OECD, 2013f).

The goal of energy RD&D policy is to help meet Sweden's energy and climate objectives (Chapter 4). Energy research and innovation is addressed in specific bills (IEA, 2013). The government's R&D budget on energy has grown steadily since 2006 and will further increase following the 2012 bill, from EUR 100 million per year to about EUR 155 million per year by 2016. The bill confirms the key priorities of the Swedish strategic approach on research and innovation, ranging from basic research to demonstration, commercialisation and product development. It identifies five priority areas: a vehicle fleet independent of fossil fuels; a power system designed around renewable electricity; energy efficiency in the built environment; increased use of bioenergy; and energy efficiency in industry.

Eco-innovation is an important component of Sweden's national environmental policy strategy. The Swedish government regards the development and use of good environmental technology as an important means of reducing the negative environmental impact of consumption and production, while promoting competitiveness and industrial growth (Swentec, 2008). Strong environmental and innovation policies have helped Sweden develop hot-spot clusters in energy and environmental technologies at European and world scale (European Commission, 2013b). Sweden has implemented a very large

number of measures to support eco-innovation in a wide range of areas, although it has put a strong focus on energy efficiency and renewable energy.[30] Prevalence has been given to supply-side instruments (information services and targeted R&D programmes). However, a quite sizeable number of demand-side instruments has also been deployed: electricity certificate systems (Chapter 4) and the charge on NO_x (Section 1.3) have been singled-out for their positive effect on innovation (WIFO, 2009). However, the EGSS has remained relatively small. A comprehensive review of the broad range of existing measures was carried out to develop an environmental technology strategy (Swentec, 2008). The review outlined the importance to tap the market potential, focusing on Swedish areas of strength and on technological fields with high potential for development. It pointed out the need to increase support to commercialisation and trade of innovative products; to promote investments in demonstration facilities; and to increase demand in environmentally driven markets. Sweden is among the most advanced EU countries in green public procurement (GPP) uptake (Box 3.1; European Commission, 2012b). However, potential remains: guidelines issued by the Swedish Environmental Management Council are not binding.

Box 3.1. **Green procurement of furniture in the region of Västra Götaland**

The Region of Västra Götaland (VGR) is one of Sweden's largest purchasers of furniture (over EUR 10 million annually). In 2002, it launched the project Considerate Design, teaming up with manufacturers to develop prototypes that met criteria for accessibility and reduced impact on the environment. The Green List (green products in the furniture contract) covers three product segments: office furniture, office chairs and furniture for public spaces, as well as fabrics/textiles. All suppliers must meet the Swedish Environmental Management Council's sustainability criteria and the more advanced criteria of the Nordic Swan eco-label for furniture and fitments.

The share of products meeting eco-label criteria has been steadily increasing – from 33% of the purchase value in 2008 to more than half in 2012, including over 450 products. The Green List has boosted knowledge and green ambitions in the furniture industry, and played a strong role in advancing the environmental maturity of the market in Sweden. Other regions and counties in Sweden use the Green List as a model for GPP of products for interiors and textiles. One of the main factors for success was collaboration with interior design companies. It was also crucial to allocate sufficient time and resources to guide and train potential suppliers and procurement staff to understand and make use of the Green List tool.

Source: European Commission (2013c), "Green procurement of furniture and fabrics for public buildings and offices".

In 2011, the Swedish government launched a strategy for development and export of environmental technology. It allocated SEK 400 million over 2011-14 to promote environmental technologies and services, including energy, waste management, water treatment and air quality. The government seeks to create conditions for the development of the Swedish environment technology sector, and thereby contribute to a better environment in Sweden and globally. By the end of 2013, 20 state-subsidised assignments had been given to 10 governmental agencies (Growth Analysis, 2013a). Direct outputs of the strategy included the launch of about 100 projects, a large number of export-promoting processes, technical visits and trips by delegations, the establishment of several Swedish

and international co-operation consortia and several well-advanced candidates for public innovation procurements. The few outcomes demonstrated so far include greater knowledge of export markets, products adapted for export markets, business relations established or developed, co-operation between Swedish and foreign partners, development of incubator processes and facilitated foreign direct investment in Sweden. Activities have been initiated regarding innovation procurement and test beds/test centres for environmental technologies. According to the Swedish Agency for Growth Analysis (Growth Analysis, 2013b), future measures should focus on activities that would otherwise not have been realised. For example, it suggests targeting support to industries that may be at risk of losing their competitive advantage from an insufficiently rapid rate of green innovation activity (Box 3.2).

Box 3.2. **Green competitiveness of the Swedish manufacturing industry**

Green competitiveness of the Swedish manufacturing industry was benchmarked using international statistics of exports and green patents over 2005-10. The results showed that Sweden's overall performance is comparable to that of Ireland, Finland, Norway and France. In Europe, Sweden is outpaced by Denmark and Germany, which both have many sectors with above-average green innovation and strong current comparative advantage. In some sectors where Sweden currently has a high level of competitiveness, emerging economies such as China and Korea but also Japan, Finland and Norway, display a considerably higher level of green innovation activity. This suggests these countries could be well positioned in these sectors to compete with Sweden in a future green economy.

Sweden seems to have a strong green competitive position in a few sectors: motor vehicles, manufacturing of special-purpose machinery and furniture enjoy a comparative advantage and are performing well in green innovation. A few sectors have remarkable performance in terms of green innovation activity, but do not currently enjoy a comparative advantage. These include non-metallic mineral products and basic precious and non-ferrous metals, as well as other smaller sectors such as refined petroleum products. These sectors may present an opportunity to maintain and expand market share in a greener economy. Of greater concern, however, is that many of Sweden's largest sectors (including telecommunication, paper and paper products, general purpose machinery and other chemical products) have a strong comparative advantage today, but may be at risk from an insufficiently rapid rate of green innovation activity.

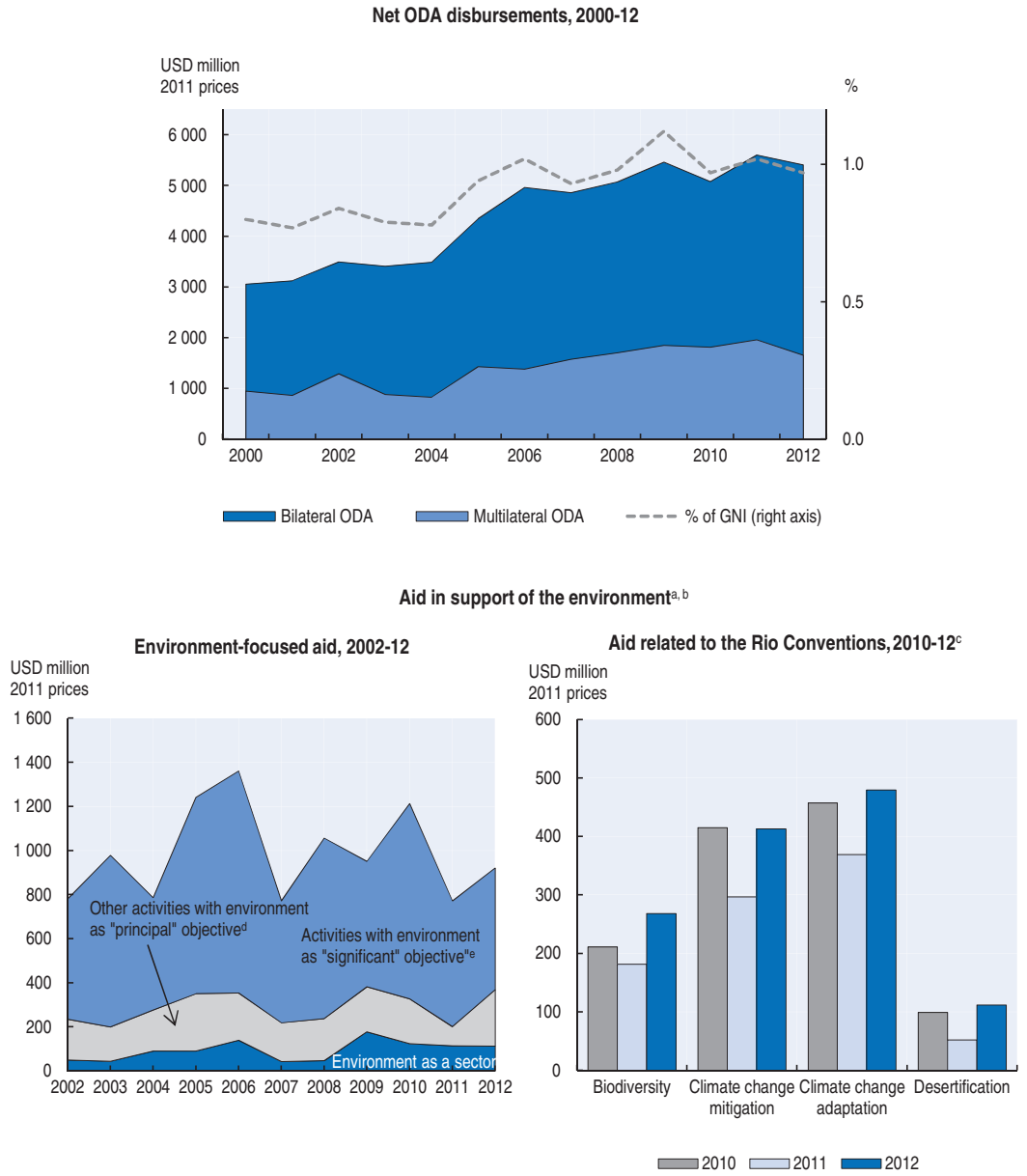
A number of caveats underpin this analysis such as the use of patents as indicators of environmental innovation, the globalised nature of the Swedish economy (which implies that green innovation may be undertaken abroad and imported), and the definition of green patents. However, these results still provide a valuable backdrop for further reviews of Swedish policy measures.

Source: Growth Analysis (2013b), *Benchmarking green competitiveness*, Report 2013:18.

5. Mainstreaming the environment in development co-operation

Since 2000, Sweden's net official development assistance (ODA) has risen by 77% to reach USD 5.2 billion in 2012 (Figure 3.9). With 1% of its gross national income (GNI) given as ODA, Sweden was the second most generous member of the OECD Development Assistance Committee (DAC) that year. This reflects its commitment since 2006 to maintain its ODA at 1% of GNI, well above the UN target of 0.7%; in 1975, Sweden became the first

Figure 3.9. **Official development assistance**



a) Commitments of total sector-allocable ODA.
b) The marker data do not allow exact quantification of amounts allocated or spent in support of the environment. They give an indication of such aid flows and describe the extent to which donors address these objectives in their aid programmes. The coverage ratio for activities screened against the environment policy marker is nearly 100% of total sector-allocable aid.
c) Most activities targeting the objectives of the Rio Conventions fall under the definition of "environment-focused aid" but there is no exact match of the respective coverages. An activity can target the objectives of more than one of the conventions, thus respective ODA flows should not be added.
d) Activities where environment is an explicit objective of the activity and fundamental in its design.
e) Activities where environment is an important, but secondary, objective of the activity.
Source: OECD (2014), *OECD International Development Statistics* (database); OECD calculations.

StatLink http://dx.doi.org/10.1787/888933145181

country to achieve the target (OECD, 2013g). In 2009-12, about two-thirds of its total ODA was allocated to the bilateral channel and one-third to the multilateral channel. The Swedish International Development Co-operation Agency (Sida) manages nearly 50% of the aid and the Ministry for Foreign Affairs (MFA) about 30%.

Sweden views environment and climate change as cross-sectoral themes and as a basis for sustainable development. "Environment and climate change" was one of three thematic priorities defined by the government in 2006. It was also identified as one of six global challenges requiring cross-government action in Sweden's 2008 "Global Challenges" (Government Offices of Sweden, 2008; OECD, 2009b). In 2010, the government issued the Policy for Environmental and Climate Issues in Swedish Development Co-operation for the period to 2014 (Government Offices of Sweden, 2010). It aims to achieve a better environment; sustainable use of natural resources; stronger resilience to environmental impact and climate change in developing countries; and limited climate impact. It focuses on five areas: strengthened institutional capacity, food security and ecosystem services, water, sustainable energy and sustainable urban development. Several flagship programmes are part of this policy, including the Environment for Development initiative (a capacity building programme in environmental economics) and the Climate and Clean Air Coalition, a global partnership to help developing countries scale up their efforts to combat short-lived climate pollutants.

Between the early 2000s and 2011/12, aid to the environment sector grew from 3-4% to 6-7% of sector-allocable bilateral ODA (Figure 3.9). Environment-focused aid[31] represented 52% of the bilateral aid in 2010/11, the third highest share among donors in the OECD DAC (OECD, 2013h). This share has been decreasing in the 2000s as bilateral aid for programmes with environmental objectives outside the environment sector remained constant in real terms in the context of growing ODA flows. In the framework of the Copenhagen pledges to scale up climate financing, Sweden invested SEK 4 billion in a climate change initiative between 2009 and 2012. Around two-thirds of the funds were disbursed to multilateral climate funds such as the Adaptation Fund, the Least Developed Countries Fund, the Climate Investment Funds, the Global Environment Facility and the United Nations Office for Disaster Risk Reduction; one-third was channelled through Sida to bilateral and regional initiatives. Results of this initiative are reflected in significant ODA commitments to the objectives of the United Nations Framework Convention on Climate Change (Figure 3.9). Unlike many DAC donors, Sweden's bilateral climate-related aid has a strong focus on adaptation. This illustrates its effort to deliver climate-resilience within ongoing development co-operation activities in sectors such as water and sanitation, agriculture and forestry. Among the five focus areas of the 2010 policy, support to the water sector more than doubled in 2012, whereas energy and urban development received less funding.

Environmental impact assessment (EIA) is mandatory for all projects as is strategic environmental assessment (SEA) to integrate environmental considerations into policies, plans and programmes. Sida has produced a handbook, *Guidelines for the Review of Environmental Impact Assessments*, for project officers and partner countries. Co-operation partners conduct the EIA, while Sida reviews the EIA and provides support. Sida's staff member responsible for the contribution decides whether programmes, projects or strategies address environmental issues sufficiently well. If there is no EIA/SEA within the background documents, Sida can either decide to help the co-operation partner conduct one or opt for a lighter process. Climate change is integrated within the environmental assessments, ensuring that focus on climate change does not divert attention from broader environmental issues. However, despite obligatory requirements, EIAs have not been systematically conducted (OECD, 2009b). The 2010 environment and climate change policy does not mention mainstreaming these issues across all of its programmes. In the MFA, environment and climate change does not have an organisational home, and several

partner countries lack focal points on these areas. While Sida's new contribution management system makes environmental screening mandatory for all interventions, more could be done to mainstream this issue, including training staff and increasing resources to support this activity (OECD, 2013g).

Since 2009, Sida has been managing the business for development programme, which includes public-private partnerships and which uses ODA to leverage other funds for development. It mobilised approximately SEK 200 million from other actors by disbursing some SEK 90 million of its own funds. Over 2009-13, the programme put special focus on environmental loans. In addition, the MFA provides a growing amount of grant money to Swedfund.[32] However, the MFA and Sida should ensure they continue to drive this agenda and be clear these partnerships must contribute to sustainable development in Sweden's partner countries (OECD, 2013g).

Notes

1. The ITR on energy is the ratio between the revenue from energy taxes and final energy consumption (Eurostat, 2013).
2. The ITR on labour is the ratio between the revenue from taxes on labour income and social contributions and overall compensation of employees (Eurostat, 2013).
3. There are also taxes on electricity consumption and nuclear power.
4. The average effective tax rate on carbon is determined by recalculating the energy tax component on the basis of the carbon content of fuels, adding the carbon tax component and taking account of exemptions and rebates.
5. The highest effective tax rate on carbon is on electricity because the calculation methodology treats taxes on electricity consumption as indirect taxes on primary fuels used to generate power, based on the carbon content of these fuels. Since a large share of Sweden's electricity comes from non-carbon sources (nuclear and renewables), the tax burden on the carbon sources is extremely high (OECD, 2013b).
6. In Sweden, such tax reform would entail a minor GDP reduction (about -0.5%) and positive employment impacts (additional 25 000 people employed) compared to the baseline. EEA (2011b) estimated the economic impact of an environmental tax reform that recycles 10% of tax revenue through spending on eco-innovation measures and the remaining 90% through reductions in income tax and social security contributions. The tax reform would include a carbon tax rate for all non EU-ETS sectors equal to the carbon price that would deliver a 20% reduction in GHG emissions by 2020; addition of aviation to the EU-ETS as from 2012; increased auctioning of CO_2 allowances in the EU-ETS; new taxes on materials at 5% of total price in 2010, increasing to 15% by 2020.
7. The basic amount is SEK 360/year. The CO_2-based component amounts to SEK 20 g CO_2/km over 117 g CO_2/km; this is halved for vehicles that run on renewables.
8. So-called environment-friendly and super-green cars are exempted from the vehicle tax for a period of five years upon first registration. An environment-friendly vehicle is defined as one equipped with technology for operation entirely or partially on electricity, alcohol or gas, or a fuel-efficient petrol or diesel car with CO_2 emissions below 117 g CO_2/km. A super-green car is defined as a vehicle with CO_2 emissions below 50 g CO_2/km.
9. In Stockholm, a charge of between EUR 1.0 and EUR 2.0 is imposed for passing a toll cordon around the inner city on weekdays, depending on the time of travel (Chapter 4).
10. The tax rates are SEK 30/kg sulphur for solid fuels and SEK 27/kg for each thousandth of sulphur content by weight in oils.
11. The NO_x charge is currently imposed on all combustion plants generating more than 25 GWh/year of heat, electricity or energy used in industrial processes.
12. Gravel is an important groundwater reservoir material. In certain parts of Sweden, gravel beds are essential for drinking water supply where natural gravel is used as a filter for purification of drinking or sewage water (EEA, 2008).

13. The allowance, amounting to EUR 0.21/km, applies when the distance between home and work is greater than 5 km, the use of a car saves more than one hour per day and commuting costs exceed SEK 10 000 per year.

14. The definition of subsidies used in Swedish environmental accounts is broader than that used in the national accounts. It includes payments from government to producers, individuals, organisations, non-profit-making associations, municipalities and county councils, as well as to EU countries and for international activities. Included in the definition are transfer payments to be used for production and investment. Environmentally motivated subsidies include funds for environment-focused development co-operation projects and managed by the Swedish International Development Co-operation Agency (SCB, 2010). These funds are excluded from the analysis presented here.

15. Mining, quarrying, manufacturing, electricity, gas and water supply.

16. Including payments for environmental protection services.

17. Ranging from SEK 2 370 per year to SEK 8 031 for households living in a house and from SEK 1 322 to SEK 5 917 for households living in apartments.

18. Sweden, like several European countries, is of the opinion that cost recovery should apply only to the supply of drinking water and the disposal and treatment of wastewater. The Commission sees water services as a wider notion that includes water abstraction for cooling industrial installations and agricultural irrigation, the impoundment or storage of surface waters for navigation purposes, flood protection or hydro power production, and well drilling for agricultural, industrial or private consumption.

19. Since 2003, about one-quarter of grants for climate investments have been allocated to production and use of biogas from waste.

20. Sweden has one of the highest incineration rates per capita in Europe.

21. Batteries, packaging, paper/newsprint, tyres, cars/end-of-life vehicles, waste electrical and electronic equipment, light bulbs and certain light fittings, pharmaceuticals, radioactive products and unclaimed radioactive sources.

22. In particular, the 2012 national waste plan set new targets to reduce food waste generation and increase source separation. The European Resource Efficiency Roadmap limits energy recovery to non-recyclable materials.

23. A set of patents protecting the same invention filed at these three major patent offices: the European Patent Office (EPO), the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO).

24. The Europe 2020 strategy sets a 3% objective for R&D intensity.

25. Sweden's share of world patents in these technologies is higher than its share in all fields.

26. The EGSS includes cleaner technologies, goods and services that prevent or minimise pollution and that minimise the use of natural resources. In Sweden, the entire turnover is counted for the resource management sector, even if only a part of this sector can be related to environmental activities. Therefore, the real turnover of EGSS activities is in the interval between the environmental protection sector (2% GDP in 2011) and the sum of the environmental protection and the resource management sectors (7% GDP) (European Commission, 2009).

27. Exports of renewable energy technology include wind and hydraulic turbines, electricity generation from renewable sources, consulting and engineering services for renewable energy.

28. A merger of the previous Swedish Trade Council and Invest Sweden.

29. For example, the Linnaeus Centre for Marine Evolutionary Biology (CeMEB) at the University of Gothenburg and the Lund University Centre of Excellence for Integration of Social and Natural Dimensions of Sustainability (LUCID).

30. With 59 measures listed, the Swedish Roadmap for the implementation of the EU Environmental Technologies Action Plan was the most extensive among the 30 countries analysed in 2009 (WIFO, 2009).

31. Including activities where environment is a principal or a significant objective.

32. Swedfund is a wholly state-owned financing company that offers equity, loans and expertise for investments in low- and middle-income countries and works with commercial partners looking to start up or expand their businesses.

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PART II

Progress towards selected environmental objectives

PART II

Chapter 4

Climate change

Sweden has shown a longstanding commitment to mitigating emissions of greenhouse gases (GHGs) both domestically and internationally. This chapter assesses the country's performance in reaching its ambitious domestic emissions reduction targets. It describes Sweden's institutional arrangements for climate change policy making and the policies and measures to reduce GHG emissions. In particular, this chapter reviews carbon pricing, in the form of carbon and energy taxes and emission trading. It discusses policies to curb GHG emissions in the transport and energy sectors, including measures to promote energy efficiency and the use of renewables.

Assessment and recommendations

Sweden has shown a longstanding commitment to mitigating emissions of greenhouse gases (GHGs) both domestically and internationally. Sweden significantly overachieved its Kyoto Protocol target, and projections show it is on track to meeting its 2020 targets of cutting emissions from sectors not covered by the European Union emission trading system (EU-ETS). Sweden aims to maintain its leadership role: it has established the ambitious, long-term objectives of "no net GHG emissions into the atmosphere" by 2050 and "a vehicle fleet independent of fossil fuels" by 2030.

Domestic GHG emissions have declined by nearly 16% since 2000, and particularly sharply since the mid-2000s; they have been absolutely decoupled from economic growth. However, GHG emissions embedded in traded goods have increased significantly. While the economic slowdown at the end of the 2000s and the relocation of industry abroad helped to meet the emission targets, an effective mix of policies has been a key factor in Sweden's GHG emission reduction. The climate policy mix has strongly relied on market-based approaches, complemented by regulations, climate-related investment subsidies, targeted support to research and development (R&D) and information-based instruments (e.g. labelling and awareness-raising campaigns).

In particular, Sweden pioneered the use of a carbon tax on energy products as a complement to energy taxes. The effective tax rate on carbon dioxide (CO_2) emissions has gradually increased and is high compared to many other OECD member countries. Sweden has participated in the EU-ETS since its launch in 2005; it covers about a third of the country's GHG emissions, mostly from industrial plants. Therefore, most sectors of the economy effectively face a carbon price.

However, there are wide differences in carbon prices across the economy, which undermines the policy's cost effectiveness: most of the carbon and energy tax burden falls on the residential, commercial and public service sectors, which face the full tax rates; non-ETS industry, agriculture, forestry, fishery, aviation and shipping benefit from tax exemptions and reductions; and the ETS sectors have paid very little, if anything, due to persistent over-allocation of free CO_2 allowances within the EU and the resulting low price. As a result, emissions have been mainly reduced in sectors where carbon prices are higher, namely the residential sector, while cheaper abatement options may have been missed. The gradual reduction of energy and CO_2 tax exemptions in 2010-15 is a welcome step forward. Some exemptions will remain, however, that are not justified on economic or environmental grounds, including on peat, one of the most carbon-intensive fuels.

With 51% of renewable energy in gross final energy consumption in 2012, Sweden has already exceeded its renewables policy objectives for 2020. Between 2000 and 2012, renewables supply grew by 18% to reach 35% of total energy supply, the fourth highest share among OECD member countries. A tradable electricity certificate system has driven the deployment of renewables in power generation more cost effectively than in several other OECD member countries. The system was adjusted in 2012 to enlarge the market (by

opening it to Norway) and to address concerns about over-compensation (by excluding old and profitable power plants). The tradable certificate system and investment grants have been decisive in attracting investment in combined heat and power production over the past decade. This has been among the key drivers of the dramatic decline of GHG emissions from space heating in buildings (by 77% between 2000 and 2011). In addition, the carbon and energy taxes have greatly influenced the relative competitiveness of heating options to the advantage of district heating and biomass. Nevertheless, Sweden should assess whether overlaps among the EU-ETS, carbon and energy taxes, renewable electricity trading, and other climate- and energy-related support measures result in higher costs of reducing GHG emissions and in displacing emissions to other countries.

The transport sector is the largest source of Swedish GHG emissions, and currently accounts for about one-third of total emissions. This underlines the size of the challenge of achieving the long-term goal of a fossil-fuel independent vehicle fleet. In addition to increasing world oil prices, several measures have helped reduce emissions from passenger vehicle use, especially since 2007, including the CO_2-based vehicle taxation, which helped improve fuel efficiency of the car fleet; tax exemptions and subsidies for so-called green and super-green cars, which encouraged sales of electric and hybrid vehicles; the congestion charge, which contributed to moderating road traffic in Stockholm and was extended to Gothenburg in 2013; and the carbon and energy tax exemption for biofuels, which now account for more than 12% of transport fuels. However, the biofuels tax exemption is a costly way of abating GHG emissions and has not provided sufficient incentives for developing more advanced alternatives.

There have been few initiatives to reduce emissions from heavy goods vehicles, which have increased since 2000. Further measures are needed to better internalise environmental costs of road freight transport by, for example, introducing emission- and distance-based road tolls for heavy goods vehicles. This would make alternative modes (rail and sea) more competitive. Insufficient availability of rail services has hampered the shift from road to rail. Planning and development of transport infrastructure could be made more consistent with climate objectives. Further measures are also needed to mitigate growing emissions from international travel, particularly by air. Sweden has supported the inclusion of aviation in the EU-ETS; 10 Swedish airports have the highest level of certification within the Airport Carbon Accreditation system.

Many of the low-cost approaches for mitigating GHG emissions have already been deployed. Thus, to avoid excessively high costs and maintain political support, Sweden will have to implement more cost-effective policies, allocate compliance costs more equitably and further encourage technological change. A comprehensive strategic action plan is needed to galvanise and guide actions by public and private actors, and to facilitate effective benchmarking of progress. The action plan should clearly specify Sweden's domestic and internationally related objectives, which are currently mixed, and set out intermediate targets.

As in many countries, responsibilities for climate-related policies are spread across several ministries and agencies. This often results in knowledge and information gaps, as well as lack of consensus on how to achieve policy objectives and implement measures; this, in turn, reduces overall transparency and accountability. While procedures to monitor GHG emissions and evaluate policy are well developed, progress reports have paid insufficient attention to the cost effectiveness and distributional consequences of climate

policies and measures. There are no general guidelines for assessing *ex ante* and *ex post* the impact of such policies on GHG emissions. The oversight of policy implementation should also be strengthened, for example, by submitting an annual progress report to Parliament.

Sweden has adopted some adaptation policy measures in the 2008/09 Climate Bill. As in other Nordic countries, estimates indicate no or positive economic impacts by 2030, although costs may outweigh benefits in the longer term. Much work has been undertaken to understand climate change impacts, identify possible responses, and share information and best practices. A review of adaptation measures is planned for 2015. This will provide an opportunity to assess the overall effectiveness of the adaptation effort, identify gaps and consider what further measures are needed. There is a need to take account of climate-related risks when assessing infrastructure projects, as well as to better use the insurance market to cover such risks.

Recommendations

- Develop a strategic action plan, including intermediate domestic targets, for achieving the 2030 and 2050 climate policy objectives; establish institutional arrangements to enhance inter-agency co-ordination for developing and implementing climate-related policies; strengthen the oversight of policy implementation, for example, by presenting an annual report to Parliament.
- Strengthen the *ex ante* and *ex post* economic evaluation of climate-related measures and policies; promote the use of consistent guidelines for this purpose, including for a consistent shadow price of carbon; and consider fully the distributional impact of policies.
- Continue to remove exemptions from carbon and energy taxes that are not justified on environmental, economic and social grounds.
- Promote greater integration of transport and climate policies, including by: ensuring that transport investments are consistent with climate policy objectives; reviewing the environmental effectiveness and economic efficiency of biofuels-support policy; and strengthening measures to reduce GHG emissions from heavy goods vehicles; accelerating the introduction of alternatives to private vehicles such as public transport and bicycle infrastructure.
- Assess the overall effectiveness of current climate adaptation initiatives in the context of the review planned for 2015; consider what further measures are needed; ensure the environmental assessment of long-life investments takes account of climate-related risks; and consider extending the use of insurance to reduce the burden of such risks on the public budget, businesses and households.

1. Climate policy objectives

Sweden has a long history of taking on, and achieving, ambitious climate targets. Ensuring a "reduced climate impact" is the first of Sweden's environmental quality objectives (Chapter 2). Government acknowledges this objective can only be achieved through international co-operation, which limits its value for guiding and monitoring domestic policy progress (Section 3.2). Sweden pursues this objective in EU and broader international forums, where it has actively promoted a comprehensive global agreement on climate protection, in line with its own domestic goals.

Sweden's domestic targets on curbing greenhouse gas (GHG) emissions are significantly more ambitious than those required by EU agreements. "Sweden's Climate Strategy", a 2001 government bill, set the target of cutting domestic emissions by 4% by 2008-12 (Kyoto compliance period) compared to 1990 levels, while the EU burden-sharing agreement[1] allowed Sweden to increase its emissions by 4% (Table 4.1). In 2008/09, Sweden approved the Climate Bill and the Energy Bill, which together set out an integrated energy and climate policy.[2] According to these bills, Swedish emissions from the sectors excluded from the EU emission trading system (EU-ETS) are required to decrease by 40% by 2020 compared to 1990, and two-thirds of the decrease must come from domestic action.[3] The Swedish Environmental Protection Agency (SEPA) estimated that this objective equates to a 33% reduction from 2005 to 2020 (SEPA, 2013a), nearly twice as much the reduction required by the EU Effort Sharing Decision (ESD) (Table 4.1).[4]

As part of its 2008/09 integrated energy and climate policy, the Swedish government adopted a vision of "no net emissions of greenhouse gases into the atmosphere" by 2050. In 2012, SEPA and a working group with wide public and private sector representation presented a proposal for a Climate Roadmap 2050 to the Swedish government. The proposal concluded that "no net emissions" was possible through a combination of domestic mitigation, increased uptake of forestry carbon sinks and the purchase of allowances. It also recommended increased targeted research and development (R&D), community planning and infrastructural investments as key elements. Also included in the Climate Bill was a commitment to develop an action plan "for a fossil-fuel independent vehicle fleet" by 2030 (Section 8). The emphasis on the transport sector recognises its central importance in Sweden's climate policy. A precise definition of these ambitious-sounding objectives and the development of plans to achieve them, however, are required to galvanise and guide action, and to facilitate effective benchmarking of climate policy progress in the medium to long term.

Table 4.1. **Sweden's climate- and energy-related policy objectives**

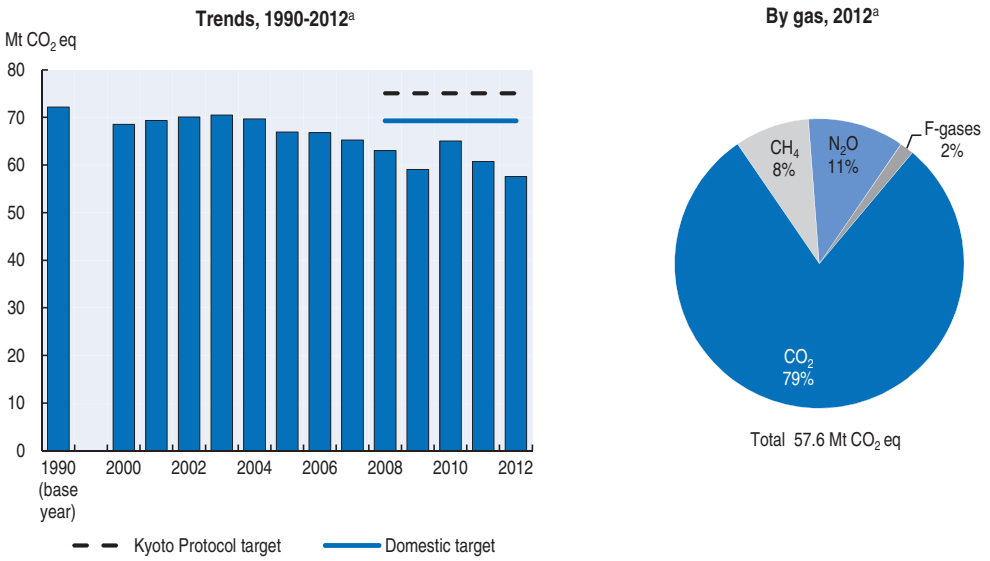
Area	Objectives required under EU agreements	Unilaterally-set objectives
Average emissions 2008-12	No greater than 104% of the 1990 baseline	No greater than 96% of the 1990 baseline (without using carbon sinks or flexible mechanisms)
Non-ETS sector emissions by 2020	17% reduction compared to 2005	40% reduction compared to 1990, or a reduction of 20 Mt CO_2 eq (equivalent to a 33% reduction by 2020 compared to 2005). Two-thirds of the decrease is to come from domestic action (without using carbon sinks).
ETS sector emissions by 2020	21% reduction on 2005 level across the EU	
Emissions by 2050	80-95% indicative target for EU emissions (agreed by European Council)	No net emissions of GHGs into the atmosphere
Renewables by 2020	49% of gross final energy consumption	50% of gross final energy consumption
Transport by 2020	10% of fuel to come from renewables	None
Transport by 2030	None	Vehicle fleet independent of fossil fuels
Energy efficiency by 2016	9% (33.2 TWh) reduction in final energy consumption compared with 2001-05 average	None
Energy efficiency by 2020	20% reduction in EU primary energy consumption compared with projected levels	20% reduction in energy intensity compared to 2008 level

Source: European Commission; Government Offices of Sweden.

2. GHG emission trends

By many measures, Sweden's performance is remarkable within the OECD context. In 2012, total Swedish GHG emissions without emissions/removals from land use, land-use change and forestry (LULUCF) were 20% below 1990 levels. Average domestic emissions over the Kyoto period (2008-12), were about 15% below the base year emissions. This means that Sweden significantly over-achieved its Kyoto and domestic targets (Table 4.1), without taking account of eligible LULUCF activities and international emission credits (Figure 4.1).[5]

Figure 4.1. **GHG emission trends and compliance with Kyoto target**



a) Excluding emissions/removals from land use, land-use change and forestry.
Source: SEPA (2014), *National Inventory Report 2014.*

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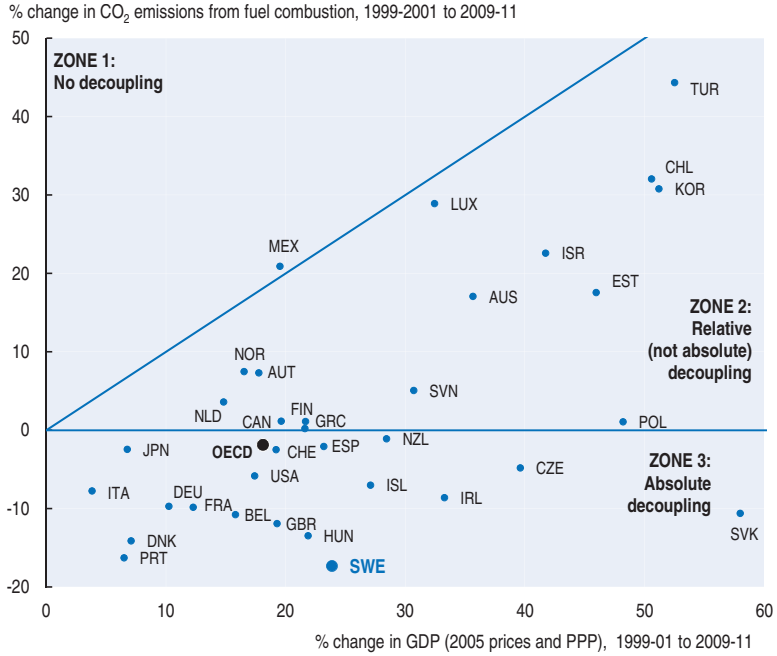
Sweden is also on track to meeting its 2020 targets for the non-ETS sector. In 2012, emissions from the non-ETS were already below the annual emissions allocation for 2013 as required by the EU.[6] National projections also show that Sweden is likely to meet its unilaterally-set non-ETS sector emission target with existing measures (SEPA, 2013a). However, the current GHG emission trajectory is not sufficient to reach the 2050 vision of almost zero emissions. The National Audit Office considers that achieving this goal requires adjustments that may come at very high costs for Sweden's economy and society (NAO, 2013a).

Since 2000, the economy has grown by 30%, while emissions have declined nearly 16% (Figure 4.1). This is one of the highest relative reductions among OECD member countries (Annex I.C). Indeed, Sweden is among the OECD member countries with the highest rate of decoupling of CO_2 emissions from GDP growth (Figure 4.2). Reductions in emissions have occurred across several key sectors, including private road transport, residential and commercial sectors, and waste management, often as a result of direct policy intervention. The economic recession resulted in a particularly sharp reduction in emissions in 2009, particularly from the industrial sector. Despite a strong economic and emission rebound in 2010, GHG emissions have continued to decrease in recent years. This is mainly due to lower emissions from road traffic, decreasing industrial production and abundant rainfall that provides plenty of hydropower and thus reduces GHG emissions from energy industries (Box 4.1).

Figure 4.2. **Decoupling CO_2 emissions from economic growth in 1999-2011**



Source: IEA (2013), *IEA CO_2 Emissions from Fuel Combustion* (database); OECD (2013), *OECD Economic Outlook No. 93* (database).

StatLink http://dx.doi.org/10.1787/888933145202

Box 4.1. **Key sectoral trends**

Energy industries (electricity generation, district heating, solid fuels and refineries) accounted for nearly 18% of overall emissions in 2012 (Figure 4.3). The small size of this sector in Sweden relative to other OECD member countries is attributable to the importance of nuclear and hydro in power generation, and biomass and waste in district heating. Although emissions in 2012 were 15% above the 2000 level, correcting for annual fluctuations (which are strongly correlated to temperature and precipitation), emissions have remained more or less constant since 2000. Greater use of biomass and waste in district heating, and of renewables for electricity generation, have helped moderate GHG emissions despite increase in electricity and heat demand (Sections 6 and 7).

The transport sector is the largest source of GHG emissions, accounting for one-third of the total (48% of non-ETS sector emissions) in 2012 (Figure 4.3). Passenger vehicles accounted for 58% of transport-related emissions, followed by heavy goods vehicles and buses (35%). Total transport emissions grew in the first half of the 2000s, but have declined steadily since 2007 to about 4% below 2000 levels in 2012 (Figure 4.3). While emissions from passenger vehicles declined since 2000, emissions from trucks increased (Section 8).

The industrial sector was responsible for a quarter of total GHG emissions in 2012 (Figure 4.3). Emissions from these sources were 25% below 2000 levels in 2012. This decline was attributable for the most part to a significant decrease in production since 2007 (Figure 4.3). Output from the iron and steel industry, the pulp and paper industry and the chemical industry has declined due to the international recession and consequent declining export figures, but also due to the replacement of oil with electricity and biofuels (for example, in the pulp and paper industry).

Box 4.1. **Key sectoral trends** *(cont.)*

Fugitive emissions and those from solvents and other product use were responsible for 2% of total emissions. Emissions from these sources almost doubled between 2005 and 2006 because two plants for hydrogen production were commissioned in that period.

Energy use in buildings (households and commercial) and in agriculture, forestry and fishing accounted for 5% of total emissions in 2012, and for 8.5% of non-ETS emissions. GHG emissions from these sources declined 61% since 2000 (Figure 4.3). This can be attributed to an expansion in the district heating network (see above), which resulted in a decline in oil and coal use for space heating. The displacement of fossil fuels for space heating by heat pumps and biomass has also played a significant role (Section 5.2). The rapid rate of de-carbonisation in the residential and commercial building sectors has no analogue within the OECD: since 2000, emissions from fuel combustion in residential and commercial buildings declined by 85% and 64%, respectively.

The agriculture sector accounted for 13% of overall emissions in 2012. Emissions from this sector (nitrous oxide and methane) have declined steadily, and were 8% below 2000 levels in 2012 (Figure 4.3). The decline is attributable to reduced livestock keeping and reduced application of N-fertilisers in agriculture.[7]

The waste sector accounted for 3% of 2012 emissions. Emissions from this source have declined 44% from 2000 levels because of waste diverted from landfills, which are the major source of GHG emissions (methane) from waste management (Figure 4.3). Other sources are wastewater management (nitrous oxide) and incineration of hazardous waste (CO_2).

The net removal for land use, land-use change and forestry (LULUCF) in 2012 is estimated at about 35 Mt CO_2 eq. Overall, the annual net removals tended to decrease during the 2000s, with the trend pointing to a decrease in net removals from the sector over the coming years (SEPA, 2013b).

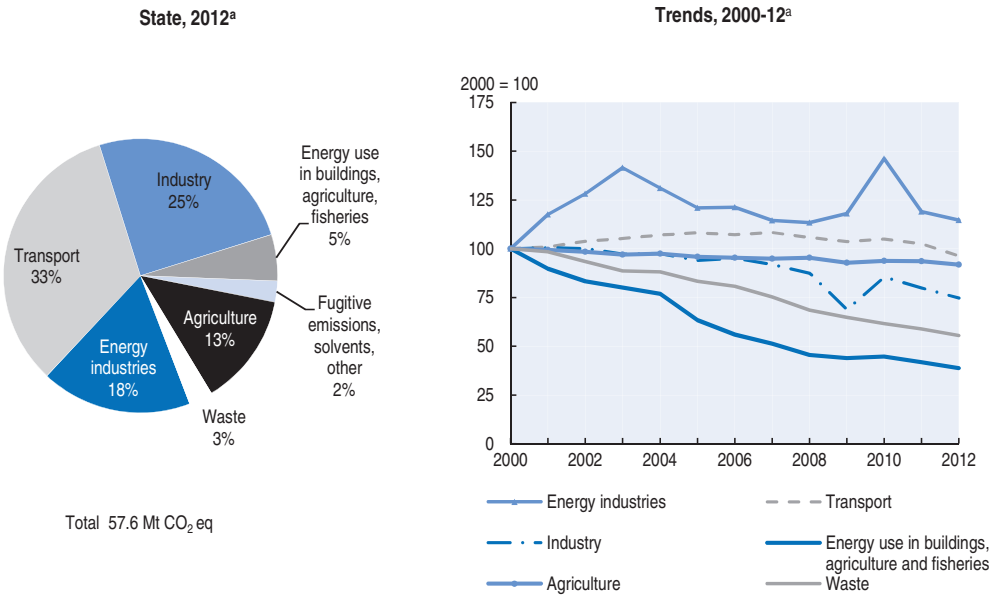
Although fuel used for international aviation and shipping is not considered in national inventories, these sources accounted for an additional 8 Mt CO_2 eq in 2012. This is attributable to international maritime emissions (73%) and international aviation (27%). Emissions from these sources have increased 18.5% on 2000 levels.

Sweden has a relatively energy-intensive economy because of its industrial structure and high energy consumption by households due to the cold climate (OECD, 2011) (Section 6). Nonetheless, the carbon intensity of Sweden's economy (the ratio of CO_2 emissions from fuel combustion over GDP) has decreased since 2000 and is the second lowest among OECD member countries. CO_2 emissions measured on a per capita basis are also low by comparison with OECD member countries, and trending downwards (Annex I.C). This mainly reflects the high share of renewables and nuclear power in the energy mix (Section 6).

The Swedish Environmental Protection Agency calculated that, while domestic GHG emissions have declined since 2000, total emissions caused by Swedish consumption grew by 16% between 2000 and 2011 (Figure 4.4). These so-called demand- or consumption-based emissions include those embodied (or embedded) in all imports consumed in a country, and exclude emissions embodied in exports (SEPA, 2012).

As in many OECD member countries, contributing factors are the increased share of imports of carbon-intensive products and relocation of activities in emerging economies.

Figure 4.3. **Greenhouse gas emissions by sector**

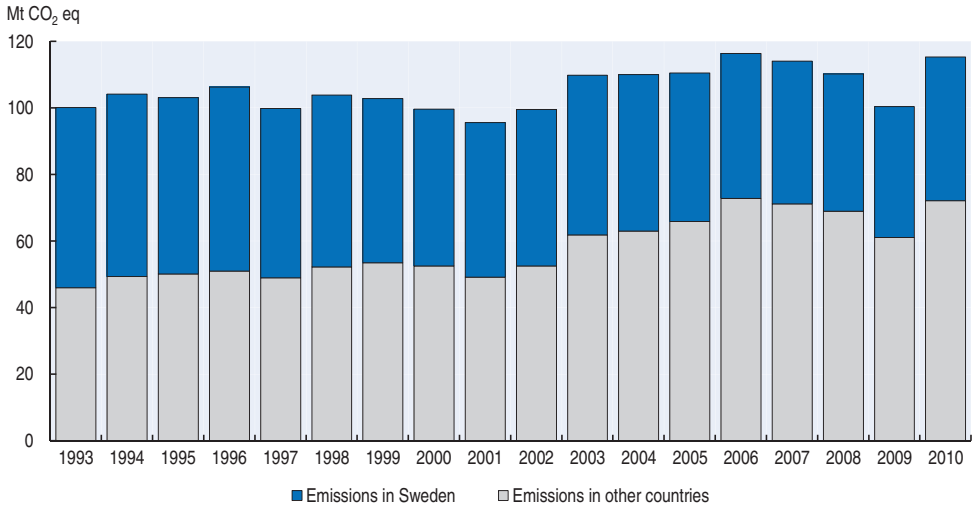


a) Excluding emissions/removals from land use, land-use change and forestry.
Source: SEPA (2014), "Sa-mar-miljon - Fakta & statistik" [State of the Environment - Statistics & Facts], SEPA website.

StatLink http://dx.doi.org/10.1787/888933145216

Consumption-based CO_2 emissions of OECD member countries were, on average, about 15% higher in 2009 than conventional measures of production-based emissions suggest. In Sweden, however, the difference was 62%, the highest of all OECD member countries (OECD, 2013a). It should be noted, however, that estimates on consumption-based emissions may not be fully comparable across countries.

Figure 4.4. **Greenhouse gas emissions associated with Swedish consumption in 1993-2010**



Source: SEPA (2014), "Sa-mar-miljon - Fakta & statistik" [State of the Environment - Statistics & Facts], website.

StatLink http://dx.doi.org/10.1787/888933145221

3. The policy-making framework

3.1. Institutional arrangements

The Ministry of the Environment has primary responsibility for climate change policy making. It delegates policy implementation to SEPA, which monitors Sweden's emissions and reports inventories and emissions projections to the United Nations Framework Convention on Climate Change (UNFCCC) and the EU.

Sweden is considered an ambitious member state in ongoing EU climate policy negotiations, interacting with both supranational and sub-national authorities to formulate and implement climate policy. For example, Sweden has consistently promoted an EU-wide emissions reduction target of 30% from 1990 levels by 2020, and is also proactive at the UNFCCC level. Like all member states, Sweden must implement EU-developed policy to reduce GHG emissions, including the first and second European climate change programmes, and the more recent 2008 EU Climate and Energy Package. Regions and municipalities have important roles in climate policy making and implementation. In meeting with a 2008 government requirement, all county administrative boards (CABs) have produced regional climate and energy strategies, in collaboration with relevant regional and local actors. The work of 14 regional energy offices and municipal energy and climate advisers, supported by the Swedish Energy Agency, is also noteworthy in this respect; a number of investment subsidy programmes (Section 6.2), which have targeted funds through regional authorities, also deserve mention. In addition, CABs play a central role in climate change adaptation policy (Section 9).

No specific legislation or new administrative routines have been introduced for the implementation of the Kyoto Protocol and post-Kyoto objectives. Climate strategies, such as the 2002 and 2008/09 legislative packages, have been developed as follows: the government tasks its agencies such as the Swedish Energy Agency and SEPA to produce background documentation, including analysis of past performance; thereafter, an ad hoc cross-party parliamentary committee produces a policy proposal report,[8] which is submitted for consultations among a broad range of authorities and stakeholders. This process has generally formed the basis of subsequent government bills to be then discussed and approved by the parliament. As a rule, all draft government bills are circulated to affected agencies and ministries for comment before being adopted by the government. This inclusive approach to decision making has tended to result in a high degree of consensus around climate policy: the process has resulted in a number of legislative packages that have been generally implemented in a timely and effective manner.

Sweden's ambitious climate policy is built on the foundations of strong public support, and a highly developed non-governmental sector that advocates for strong climate action (Chapter 2). Over 98% of Swedes consider environmental issues to be "very important" or "fairly important" (European Commission, 2011), which is among the highest of all EU member states. The level of environmental activism and awareness is partly attributable to the government's proactive approach to public awareness. Several initiatives have been launched since 2002, including a 2002-03 campaign to increase knowledge of the causes and consequences of climate change, and a 2006-08 campaign to disseminate findings of the latest research; analysis suggests these campaigns have helped improve knowledge about the climate issue (Ministry of the Environment, 2009).

Responsibility for measures that have an impact on emissions is, however, spread across many ministries and numerous government agencies, whose main tasks and

objectives are, in many cases, not climate-related. Fragmented responsibilities often result in lack of consensus on how to achieve policy objectives and implement measures, as well as in knowledge and information gaps (NAO, 2013a). This reduces overall transparency and accountability, making it difficult to implement policy and streamline efforts.

3.2. Monitoring of progress

Every four years, SEPA, together with the All-Party Committee on Environmental Objectives, undertakes an in-depth review of progress in achieving the 16 environmental quality objectives (Chapter 2). This includes assessing progress towards the goal of the "reduced climate impact". The climate policy objective, however, does not facilitate assessment of domestic progress in implementation and emissions mitigation. Instead, "reduced climate impact" requires action at the international level, not only action by Sweden. Therefore, successive evaluations indicate that Sweden is failing to meet this objective, even though it has met its own GHG emission mitigation targets (Section 2). Setting an unattainable objective is of questionable value, and the related performance assessment may not give sufficient recognition to Sweden's many achievements in domestic climate policy.

Annual GHG emission monitoring is fully consistent with UNFCCC common reporting format guidelines; emissions data are published annually. In-depth reviews of climate policy implementation, or "control stations", are undertaken periodically as required by law. A review of the 2002 climate strategy occurred in 2004, and a second review was initiated in 2007. A further control station will be conducted in 2015 to assess progress, which may result in adjustments to policy instruments and tools.

NAO (2012; 2013a), however, has expressed concerns that progress reports have paid insufficient attention to the distributional consequences and cost effectiveness of meeting agreed targets. The ministries and agencies in charge of monitoring and reporting on policy implementation often adopt different analytical approaches, which can result in information gaps and inconsistencies. In particular, there are no general guidelines for conducting cost-benefit analysis (CBA) and evaluating impact of projects and policies on GHG emissions, with often large differences in the shadow prices used. CBA is mandatory for transport projects, but not for energy projects and other major governmental regulations.[9] There is no annual review of progress in a parliamentary committee, as would be the case in countries such as the UK and Ireland.[10] These shortcomings make it challenging to benchmark progress against the GHG mitigation target, and is perhaps sub-optimal for enabling understanding and discussion of progress in civil society.

Swedish institutions and processes for developing and implementing climate policy can be considered to have delivered effective results to date. However, as attempts are made to deliver increasingly ambitious objectives (for example, a vehicle fleet independent of fossil fuels by 2030) in a cost-effective and equitable manner, more transparent benchmarking of progress and robust assessment of effectiveness, costs and distributional implications of policy measures is required.

4. Overview of policies and measures to reduce GHG emissions

Sweden has introduced a range of policies and measures to reduce GHG emissions and meet its domestic and international commitments. In addition, several instruments that aim to achieve other policy goals than the climate objective, such as those related to

energy, also affect GHG emissions. Economic instruments such as carbon tax and emission trading are at the core of Sweden's climate policy (Section 5). These are supplemented by other instruments, including technology procurement, vehicle taxes, renewable energy certificates and investment grants. These additional measures aim to support the development and market introduction of technology, eliminate barriers to energy efficiency and renewables, and improve political acceptability of climate policy (Ministry of the Environment, 2013). Table 4.2 summarises current climate-related policy measures. The key measures will be analysed in more detail in the following sections of this chapter.

Table 4.2. **Climate-related policies and measures**

Sector	Carbon pricing	Other measures
Energy supply	EU-ETS[a] Energy and CO_2 taxes covering the remaining part of emissions, with exemptions and reduced rates (Table 3.1)	Electricity certificate system Investment and R&D subsidies for wind, solar, biogas and advanced biofuels
Industry	EU-ETS[a] Energy and CO_2 taxes for industries not covered by the EU-ETS, with exemptions and reduced rates (Table 3.1).	F-gas regulation[a] Programme for energy efficiency in industry
Transport	Energy and CO_2 taxes (full rate)	CO_2 requirements for new vehicles[a] Tax exemption/quota obligation for biofuels CO_2-differentiated vehicle tax Incentives for green vehicles Car-benefit taxation Infrastructure planning
Residential and services	Energy and CO_2 taxes (full rate)	Buildings energy performance certificates[a] Eco-design and energy labelling[a] Building regulation Energy advice Technology procurement Subsidies for improved window insulation
Agriculture	Energy and CO_2 taxes with exemptions and reduced rates (Table 3.2).	Support for biogas Restrictions on fertiliser use Rural development programme[a]
Waste		Landfill ban[a] Methane recovery Extended producer responsibility National and municipal waste management plans
Other/general		Environmental Code Planning and Building Act Research and development programmes, including for biofuels and energy efficient vehicles Climate investment programmes

a) EU-wide instruments.
Source: Adapted from Ministry of the Environment (2013), *Sweden's Sixth National Communication on Climate Change under the United Nations Framework Convention on Climate Change.*

As in all countries, the cost of reducing a tonne of CO_2 emissions varies substantially across different policy measures and sectors of the economy. There is also a lack of co-ordination between domestic and EU measures, including the EU emission trading system (Section 5.2). This results in a loss of cost effectiveness because different GHG emission sources face different costs for their emissions, as analysed in the following sections.[11] Improving the cost effectiveness of the policy mix is even more important in light of the ambitious future targets. The costs of further reducing GHG emissions to achieve the 2020 target could be high (OECD, 2011; NAO, 2013a). In addition, SEPA estimates that achieving the longer-term zero emissions goal will cost between 0.2-0.5% of GDP in 2050 (NAO, 2013a).

5. Pricing carbon

5.1. *Carbon and energy taxation*

Sweden's energy taxes are based on two components: one based on energy content of fuels and the other based on the carbon content of fossil fuels, i.e. the CO_2 or carbon tax component. The CO_2 tax or carbon tax was introduced in 1991 within the existing system of energy taxes, which simultaneously were nearly halved. The nominal carbon tax rate has gradually increased, reaching EUR 119 per tonne of CO_2 in 2013, while taxes on labour have been reduced (Chapter 3).

As energy users face both an energy tax and a carbon tax, and in some sectors can benefit from a number of tax exemptions and rebates, the average effective tax rate on carbon largely differs from the nominal carbon tax rate and varies across energy products and uses (OECD, 2013b). In 2009, Sweden passed legislation to partially reform the energy and CO_2 taxes and gradually reduce exemptions in the period 2010-15 (Chapter 3). According to analysis by the National Institute of Economic Research for the Swedish National Audit Office (NAO), this reform will help reduce emissions to 2030, although only to a limited extent. The tax restructuring is not expected to negatively affect the economy in the long term, or entail any major general tax increases. Not surprisingly, reducing exemptions from the CO_2 tax is also expected to increase its cost effectiveness over the period 2010-15 (NAO, 2012).

Progress notwithstanding, disparities remain that are not justified on economic or environmental grounds. These include reduced rates for agriculture and industry outside the ETS, and full exemption of biomass, biofuels and peat from both the energy and carbon tax. While electricity generation from peat is subject to the EU-ETS, the exemption from the energy tax can be seen as an environmentally harmful subsidy because peat is one of the more carbon-intensive ways to generate energy.[12] Overall, most of the carbon and energy tax burden falls on households, even though they account for a relatively minor share of emissions (Box 4.1 and Figure 4.3). The EU emission trading system, analysed in Section 4.2, tends to increase disparities across sectors of the economy (NAO, 2012).

More generally, phasing out the exemptions would result in a more uniform effective tax rate on carbon, which would improve cost effectiveness. There may be some risk of "carbon leakage", i.e. relocation of production to countries with no or lower energy and carbon taxation levels, if exemptions are further reduced. However, leakage risks are often exaggerated for several reasons: the carbon tax rate is only one input to location decisions, it represents a relatively minor share of business costs and other countries also tax energy-intensive industries (Jamet, 2011; NAO, 2012).

Due to exemptions for the industrial sector outlined earlier, the primary impact of the carbon tax has been in the commercial, residential and public buildings sector. As the carbon tax does not apply to non-fossil fuels like biomass and biofuels, the use of biomass in the Swedish district heating system and that of transport biofuels have increased (Sections 6.2 and 8). With respect to transport, the carbon tax has had limited impact on the total price of road fuels (NIER, 2012); this suggests the price of crude oil has been a more important factor in moderating the use of passenger vehicles and in encouraging a shift to diesel vehicles.

The few evaluations of the carbon tax impact on GHG emissions are relatively old (OECD, 2011). The Ministry of the Environment (2013) acknowledged that the use of several policy instruments in the area of climate change makes it difficult to assess the impact of

each instrument and, in particular, of the carbon tax. Extrapolating the results of a 1997 study to the 1991-2010 period, Jamet (2011) estimated the carbon tax has led to a reduction in emissions of between 0.2% and 3.5%.[13]

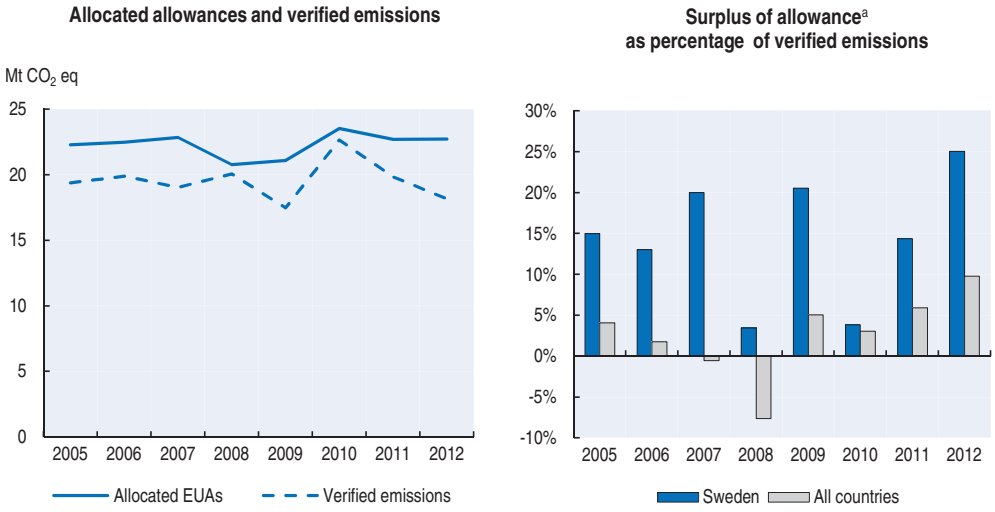
5.2. *Emission trading*

Sweden has participated in the EU-ETS since its launch in 2005. The EU-ETS covers CO_2 emissions from electricity and heat generation plants, refineries and installations that produce and process iron, steel, glass, cement, ceramics, and pulp and paper. Since 2012, emissions from aviation have also been included, while the aluminium industry and parts of the chemical industry and waste incineration have been covered since 2013.

The ETS covers about 33% of Swedish GHG emissions over 2008-12 compared to approximately 41% of the EU's GHG emissions. Some 80% of covered emissions come from industrial installations in Sweden, whereas the corresponding figure for the EU-ETS is 40%. The remaining 20% of emissions come from power and district heating installations (EEA, 2013a; Ministry of the Environment, 2013). This is because of the high proportion of electricity generated from renewables and nuclear in Sweden. The EU emission trading system is, therefore, the most important climate policy instrument for the industrial sector.

The first trading period (2005-07) was characterised by a general over-supply of EU CO_2 allowances (EUAs) to the sectors of the economy covered by the EU-ETS.[14] This resulted in the price drop of an EUA from about EUR 25 per tonne of CO_2 to nearly zero in spring 2007. Over-supply was larger in Sweden than in the whole market: allocated allowances were about 16% above the level of verified CO_2 emissions in 2005-07 compared to an average of 2% in the whole system (Figure 4.5).

Figure 4.5. **Allocated and verified CO_2 emissions in the ETS in 2005-12**



a) Difference between allocated and verified emissions.
Source: EEA (2014), *EU-ETS data viewer* (database).

StatLink http://dx.doi.org/10.1787/888933145232

In the second trading period (2008-12), the EU-wide emission cap was tightened. While most countries had to accordingly tighten their national emission allocations, Sweden's plan allowed emissions covered by the EU-ETS to grow by 5% compared to verified

emissions in 2005 (EEA, 2013a). Sweden allocated all the allowances for free, although no free allocations were made to existing plants in the electricity and district heating sector (Ministry of the Environment, 2013). This resulted in a 13% surplus of allowances in 2008-12, compared to an average 3% in the whole system (Figure 4.5).[15] After peaking in May 2008, the price of EUAs again collapsed, reaching a low of under EUR 3.00 in 2013. This is mainly due to the long-lasting economic crisis in Europe and consequent decline in economic activity relative to projections (EEA, 2013a).

Sweden will join the efforts of the European Union to achieve the Union-wide target of reducing emissions by 21% relative to 2005 over the period 2013-20. The European Commission will supervise allocations, with auctioning of EUAs introduced immediately for the energy sector, and gradually phased in for all other sectors, depending on their exposure to carbon leakage. However, the Commission expressed concern that the surplus of allowances may persist through the third trading period, affecting the ability of the EU-ETS to meet the ETS target in a cost-effective manner (European Commission, 2012).

Despite the persistent over-supply of free allowance and their low price, Sweden's CO_2 emissions from the sectors participating in the ETS decreased by 6% between 2005 and 2012 (Figure 4.5). In interview surveys, over 50% of Swedish operators replied that the ETS had encouraged their companies to cut energy use and CO_2 emissions, primarily in the energy supply and pulp and paper industries (Ministry of the Environment, 2013). Measures taken included increasing the capacity of biofuel plants, investing in waste-fired boilers (burning industrial waste), improving combustion efficiency, increasing use of district heating and converting oil- to biofuel-fired boilers. However, Löfgren et al. (2013) found that GHG-reducing investments have been primarily driven by issues such as energy intensity of the companies' production process and earlier investments in green R&D rather than by participation in the EU-ETS.

Companies in the ETS sector have in practice paid very little – and in some cases nothing – due to persistent over-allocation of free permits, and the resulting low permit prices. Some installations may have even gained from selling the allowance surplus, whose total value for the two trading periods can be estimated at just over SEK 1.8 billion (NAO, 2012).[16] In addition, because the carbon tax has been abolished for most ETS companies since 2011, this sector is expected to pay SEK 5.6 billion (about EUR 640 million) less on energy and carbon taxes in 2009-15. Non-ETS sector companies, on the other hand, are expected to pay SEK 4.2 billion (about EUR 480 million) more on energy and carbon taxes over the same period (NAO, 2012). Non-ETS sectors, therefore, shoulder most of the burden, and cheaper abatement opportunities in the ETS sectors are likely to be missed.

NAO (2012) expressed concerns that the specific costs to businesses and households of energy and CO_2 taxes and the EU-ETS have not been made sufficiently clear. It judged analyses fragmentary and insufficient for well-founded decisions to make the climate-related measures more effective. In addition, NAO (2013a) called for an analysis of the interactions between the EU-ETS and the carbon tax, as well as of these two pricing instruments and Sweden's policy to support renewables and energy efficiency. OECD analysis shows that, when a carbon price exists, applying other policy instruments could lead to overlap and undermine cost effectiveness. In particular, support measures for renewable and energy efficiency can depress the demand and price of ETS allowances and lead to displacement of GHG emissions in Europe. These and other instruments should be used only when a carbon price cannot fully address a market failure (OECD, 2009).

6. Policies and measures in the energy sector

Sweden has a diversified energy mix. Fossil fuel sources (oil, coal and natural gas) accounted for 31% of total primary energy supply (TPES) in 2012, a share well below the average of OECD member countries, as well as of many other European countries (Annex I.A). Nuclear energy accounted for 33% of TPES and 38% of electricity generation (Box 4.2). Energy supply from renewable sources reached more than 35% of TPES in 2012 (Figure 4.6; Section 6.1). This is the fourth highest rate of renewables in energy supply among OECD member countries (Annex I.A). As a result, the carbon intensity of energy supply is very low by international comparison. Sweden had the fourth lowest carbon intensity of electricity and heat production in the OECD in 2011 (Figure 4.7).

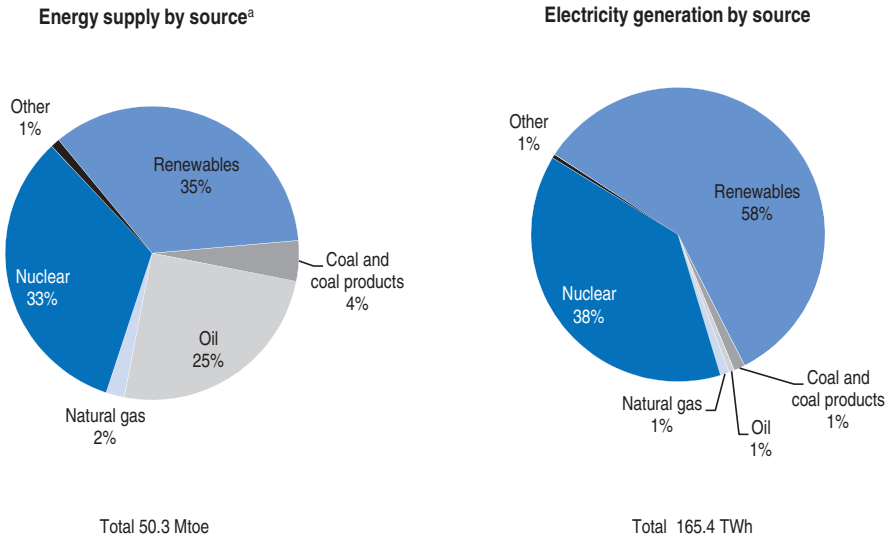
Box 4.2. **Nuclear power**

Further to the integrated energy and climate policy of 2008/09, nuclear power has been identified as one of the pillars of Sweden's low-carbon electricity supply. A decision was taken to allow the replacement of nuclear reactors at the three existing sites at the end of their operational lifetime. A permit to construct and operate a new nuclear facility requires that the new unit replace an existing one, the older reactor be permanently disabled and the new one be built in the same location.

Legislation has also been amended to establish unlimited liability for operators. Over the past decade, industry has pursued a modernisation and power upgrading programme, while the monitoring and supervision of nuclear power plant operations have also been strengthened. The government does not provide any direct or indirect subsidies for new nuclear power.

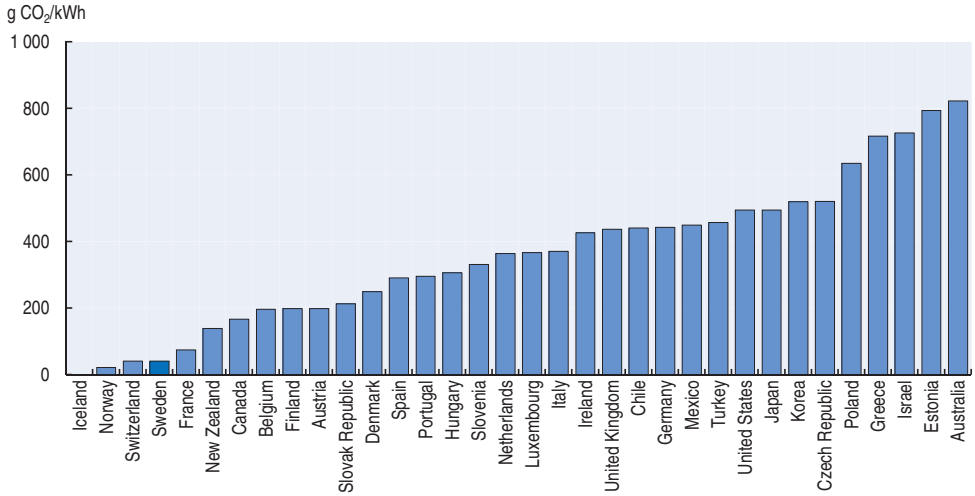
Source: IEA (2013), *Energy Policies of IEA Countries: Sweden 2013 Review.*

Figure 4.6. **Energy structure in 2012**



a) Total primary energy supply, excluding trade of electricity and heat.
Source: IEA (2013), *IEA World Energy Statistics and Balances* (database).

Figure 4.7. **CO_2 intensity of electricity and heat generation in 2011**



Source: IEA (2013), *IEA CO_2 Emissions from Fuel Combustion Statistics* (database).

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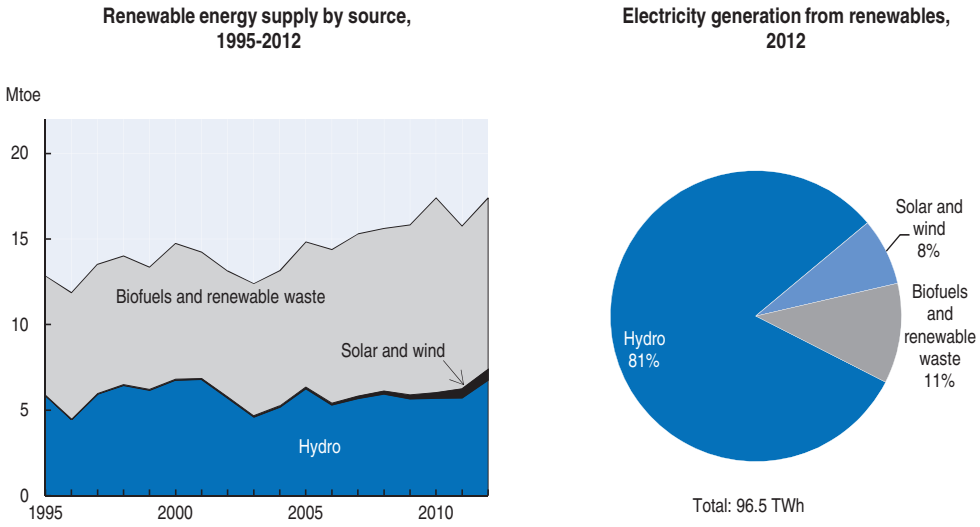
Renewable energy supply increased by 18% in 2000-12; this resulted from the growing use of biofuels and waste in electricity, heat production and the pulp and paper industry, as well as the increase in production of electricity from wind. Biofuels and waste represent the largest category of renewable energy in the country (58% of TPES from renewables), followed by hydropower (39%), and solar and wind (4%). Hydropower accounts for the vast majority of electricity from renewables (Figure 4.8). Generation from wind power increased significantly, growing from only 0.3% to 4% of total electricity generation between 2000 and 2012. Most of the future additions in renewable energies are expected to come from wind power.

Figure 4.8. **Energy and electricity from renewable sources**



Source: IEA (2013), *IEA World Energy Statistics and Balances* (database); OECD calculations.

StatLink http://dx.doi.org/10.1787/888933145257

As part of its 2008/09 integrated energy and climate policy, Sweden has set an ambitious target of achieving 50% of renewable energy in gross final energy consumption by 2020. This was an increase of one percentage point on the requirement of Renewable Energy Directive 2009/28/EC (Table 4.1). Sweden's renewable energy action plan (2010) set targets for renewables in electricity of 63%, in heating and cooling of 62% and in transport of 14% by 2020. Sweden is already well ahead of milestones required by the directive. It has also exceeded its 2020 target, having reached an overall share of renewables of 51% in 2011. Sweden has also exceeded the 2020 target for renewables in the heating and cooling sector (Table 4.3).

Table 4.3. **Progress towards the 2020 targets for renewable energy sources**

Renewable energy sources for:	Renewables as a share (%) of gross final energy consumption				
	2005 baseline	2010 achieved	2010 target	2012 achieved	2020 target
Heating and cooling	53.7	65.0	57.0	65.6	62.1
Electricity generation	50.9	56.0	54.9	60.0	62.9
Transport	4.0	9.8	7.4	12.6	13.8
Total	39.7	47.8	43.5	51.0	50.2

Source: Government Offices of Sweden (2010, 2011a, 2013).

6.1. Renewables in electricity

The tradable electricity certificate (TREC) system is the primary policy instrument to drive the deployment of renewables in electricity. Under the system, introduced in 2003, electricity suppliers, and some consumers and industries, are obliged to acquire renewable energy certificates each year in proportion to their electricity sales and consumption: this creates a demand for certificates. Producers of electricity from renewable energy sources receive an electricity certificate for every megawatt-hour of electricity produced: this creates a supply for certificates. The quota is increased over time in line with objectives for renewables. To galvanise investments where they are most cost effective, the system is technology neutral, meaning that all renewable energy technologies are eligible for certificates. The system also supports the use of peat in CHP plants, although this is questionable on environmental grounds considering the high carbon content of peat. Sweden claims that the use of peat can have a net positive effect on the climate since it improves the combustion process when co-fired with solid biomass (IEA, 2013).

The 2010 Electricity Certificates Act proposed a 25 TWh increase in the quota obligation by 2020 compared to 2002. Two additional amendments have improved system design. First, the system was also extended until the end of 2035 (with adjustments possible further to regular reviews, the first of which will take place in 2015). It is, indeed, essential that a credible authority guarantees a tradable certificates system for a specific and sufficient time horizon; otherwise, uncertainty may turn off potential investors (Haas et al., 2010). Second, the scheme was extended to include Norway, which joined in January 2012, aiming to enhance cost effectiveness by creating a larger and more liquid market for certificates.

Sweden's implementation of the certificate system has delivered positive results in terms of effectiveness. It has met its primary objective of driving renewables deployment: certificates issued in 2011 nearly doubled compared to 2004. A survey of energy companies and forest industries shows the TREC scheme has often been decisive in attracting

investment in CHP production (Hirsmark and Larsson, 2005). The greatest number of certificates has been issued for biofuel-based electricity production in CHP systems, followed by wind, hydro and peat. However, wind power accounts for more than 50% of all certificates issued to new plants since 2004 (IEA, 2013). This performance compares favourably with that of other countries such as the UK, where policy uncertainty, as well as administrative and planning barriers, and resultant delays, appear to have reduced effectiveness (Haas et al., 2010). The existence of effective, proportionate and dissuasive penalties for non-compliance is one factor underlying the effectiveness of the system.[17]

In terms of cost effectiveness, costs (passed through to consumers through increased electricity prices) are minimised because the certificate scheme generally works to incentivise technologies closest to market (IEA, 2013). Furthermore, a renewables certificate system places less of a burden on the regulator to respond to unpredictable changes in the cost of technologies – changes that could otherwise result in higher than anticipated costs (OECD, 2012). The price of certificates has been lower than under similar schemes in Europe, such as in Italy and the UK (Haas et al., 2010). The average price of certificates declined somewhat from a high in 2008 (between SEK 350 and SEK 400) to SEK 150 at the end of 2011. The total cost of the scheme in 2011 was EUR 477 million, which resulted in a modest average cost pass-through to consumers of EUR 0.005 per kWh (IEA, 2013).[18]

Nevertheless, OECD (2011) found that deadweight losses to electricity users (matched by gains to incumbent electricity users) were significant. This was because a majority of the certificates (76%) had been distributed to old and profitable plants that would have produced renewable electricity anyway. In a welcomed move, the new Act for Electricity Certificates (2012) has, however, made several amendments to the system to avoid overcompensation. Commercially viable older plants (including biofuel-fired CHP) have been or will be excluded;[19] new plants are entitled to certificates for a maximum of 15 years; and large hydropower plants (installed capacity over 1.5 MW) are excluded entirely.

The existence of various market failures that act as barriers to renewables deployment has been used to justify the existence of an additional instrument (beyond the ETS) to promote renewables. While governments should not try to pick technology winners, it may be necessary to introduce targeted policy instruments in addition to taxes or emission trading. Such instruments could accelerate technology change and bring promising new technologies to market. Electricity certificate systems, for example, have been found to have a positive effect on innovation, although the impact is less than for specific R&D policies. More targeted subsidies are required to induce deployment of more costly energy technologies, such as solar power, while a targeted R&D policy can have better results at earlier stages of the innovation cycle (Johnstone et al., 2010).

Beyond the certificate programme, Sweden offers investment support for certain types of renewable technologies, including solar PV and biogas for transport. When the impact of the electricity certificate scheme on wind investments became clear, support for wind was phased out in 2012. However, wind benefits from reduced real estate tax and energy tax. Support will continue to 2016 for other technologies (Table 4.4).

Grid connection has been a barrier to renewables deployment, with delays of up to five years the norm (IEA, 2013). Stronger connection between generation and network planning was introduced in the Electricity Act 2009 to address this challenge. Additional measures to support renewables are included in Sweden's action plan for renewable energy, and legislation to facilitate grid connection and reduce entry barriers to renewables is under

Table 4.4. **Overview of main investment subsidies**

Measure	Sector	Start	End	Budget (SEK million)
Investment grant or loan (up to 45% of investment cost)	Solar PV connected to the grid	2009	Extended to 2016	222 in 2009-11 60 in 2012 210 in 2013-16
Investment aid for production, distribution and use	Biogas and other renewable gases	2009	Extended to 2016	280 in 2013-16
Investment aid for urban planning and development	"Sustainable cities"	2009	2012	320 in 2009-10 40 in 2011-12
Investment aid, R&D and marketing (pilot fund)	Wind power	2003-07	2008-12	400 in 2003-09 350 in 2008-12 10 per year in 2013-16

Source: IEA (2013), *Energy Policies of IEA Countries: Sweden 2013 Review*.

development. A national planning framework for 30 TWh generation by 2020 (20 TWh onshore, 10 TWh offshore) has been set out to provide orientation to municipal spatial planning procedures.

6.2. Renewables in heating and cooling

One of the achievements of Swedish policy has been the 77% reduction in GHG emissions arising from space heat in residential and commercial buildings between 2000 and 2011. Iceland is the only other OECD member country that experienced a similar GHG emission decline from this sector. Rapid fuel switching in the existing district heating network, investment in new district heating and extensive deployment of heat pumps are the key developments underlying the trend. Several distinctively Swedish conditions paved the way to this transformation: a pre-existing district heating sector, largely in the hands of municipalities; the high acceptance for community-wide technical solutions in Sweden; the reliability of CHP systems; the absence of a natural gas grid; large forestry resources and an existing infrastructure in a well-developed forestry sector; and the development of technical standards and joint research in the district heating sector (Nilsson et al., 2004).

The energy and carbon tax system and subsidy programmes helped make investment in district heating and CHP competitive. Increasing electricity prices and the carbon tax greatly influenced the relative competitiveness of heating options to the advantage of district heating and made biomass the cheapest fuel in heat production (Ericsson, 2009). The landfill tax increased the attractiveness of using municipal solid waste incineration and industrial waste heat, although the availability of waste has mainly been driven by the bans on combustible and organic waste in landfills (Box 4.3).

The Swedish scheme for tradable renewable electricity certificates has been a key driver of the great increase in the biomass-based combined electricity and heat production (Section 6.1). Investment grants such as the local climate investment programmes (KLIMP) have also stimulated a rapid expansion of the district heating network and of CHP installed capacity. The KLIMP, which superseded the local investment programmes (LIP) that ran in 1998 and 2002,[20] allocated SEK 1.2 billion to climate investment over 2003-12, mainly to energy, transport and biogas projects. These subsidies, now discontinued, played an important role in the connection of one- and two-dwelling buildings to district heating systems and the establishment of small-scale district heating systems (Ericsson, 2009); they are estimated to have delivered a further 0.64 Mt CO_2 eq annual mitigation (SEPA, 2013c). Subsidy programmes supporting conversion of residential buildings from electric heating

Box 4.3. **The contribution of waste management to reducing GHG emissions**

Swedish waste management legislation and taxes have, in combination with the energy and carbon taxes, been strong drivers for diverting waste from landfills towards recycling and waste incineration with energy recovery in district heating systems. The legislation includes a ban on combustible waste in landfills (from 2002), and a ban on organic waste in landfills (from 2005). In addition, a landfill tax for waste exempted from the bans has been implemented since 2000 (at the level of SEK 250/tonne), which has been increased gradually (SEK 435/tonne by 2006). Despite high capital costs associated with waste incineration, it has been possible to charge relatively low gate-fees for the waste due to revenues from heat sales. The substantial decrease in the discarding of waste in landfills and an increase in waste incineration has resulted in a dramatic decline of GHG emissions from waste management (Box 4.1). However, the expansion of waste incineration can undermine prevention and recycling of waste and threatens the financial sustainability of the waste management system (Chapter 3).

systems to other energy sources have helped further expand heat pump use, as well as reduce electricity and oil use in home heating. Between 1996 and 2006, the sale of heat pumps increased at an average of 35% per annum (Kiss et al., 2012).[21] By 2010, some form of heat pump was in use in 46% of the country's detached houses (Swedish Energy Agency, 2013).

A key justification for these investment programmes was to overcome information barriers and to ensure the dissemination of best practices and greater awareness of climate issues in municipalities. Assessments have found that the LIP and KLIMP achieved these objectives. KLIMP was also found to have helped develop environmental technology and, in some cases, increased exports (Chapter 3). Co-benefits have included reduced emissions of nitrogen oxides, sulphur, particulates and volatile organic compounds (SEPA, 2013c).

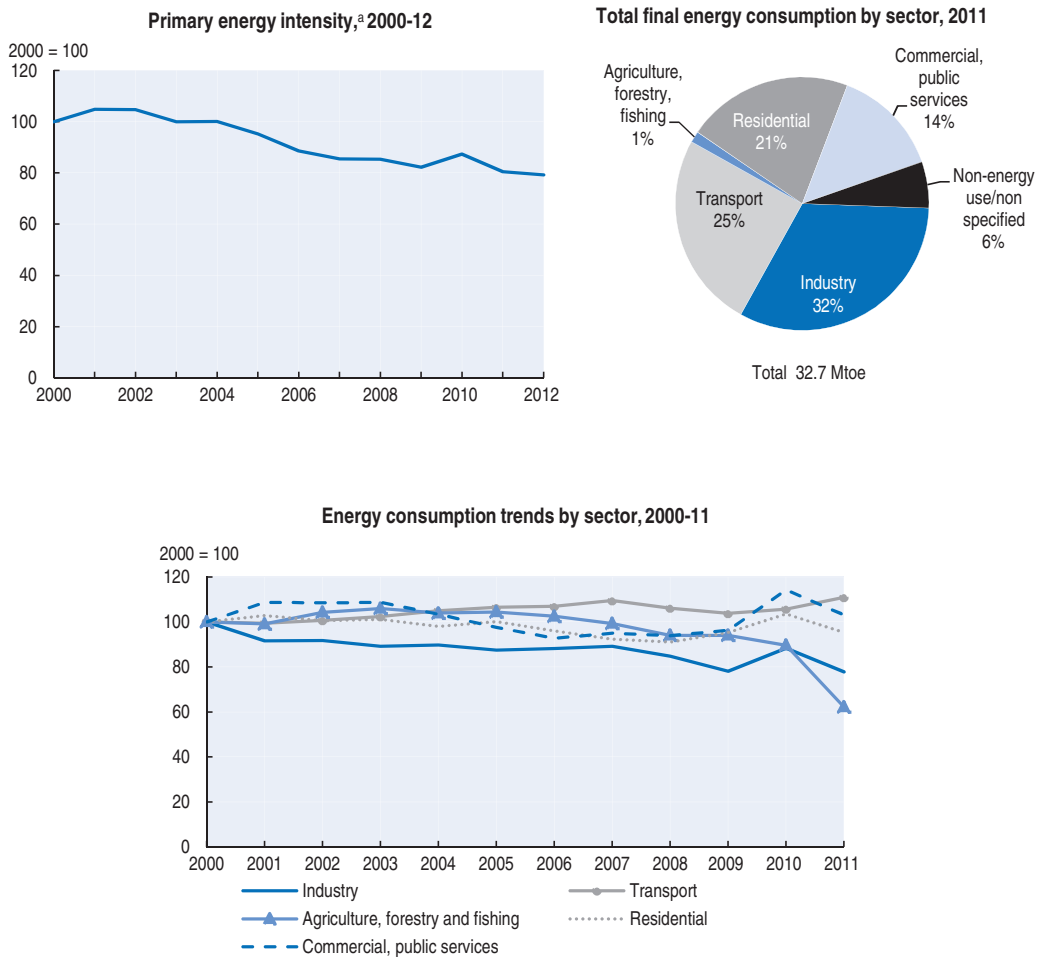
The LIP and KLIMP have, however, been criticised for poor cost effectiveness. A key concern has been lack of additionality: some estimates suggest that up to 70% of investments would have occurred without subsidy. Still, investment subsidy programmes may have brought forward these investments, or ensured they had higher environmental standards (OECD, 2011). The change in heating systems and fuels may have been sufficiently attractive on economic grounds without subsidies because of ageing oil boilers, increasing oil and electricity prices, and carbon and energy taxes (Ericsson, 2009). Some criticisms of KLIMP and LIP, however, could be addressed by developing a more robust assessment process, including cost-benefit analysis of projects to ensure that no projects are subsidised unnecessarily.

7. Policies and measures to promote energy efficiency

The energy intensity of Sweden's economy, measured as primary energy used per unit of GDP, is relatively high. It is in line with the OECD average, but higher than that of many other European countries (Annex I.A), due to the country's heavy industrial base and high heating needs. Nonetheless, energy intensity declined by 21% between 2000 and 2012, as total primary energy supply has grown at a lower rate than the economy (by 2.8% compared with 30%) (Figure 4.9). These improvements can be attributed to both energy efficiency policy (see below), as well as structural changes to the Swedish economy (IEA, 2013). In 2011, final energy consumption was 7% below its level at the beginning of the decade. As

Figure 4.9 shows, the largest share of consumption is in the industrial sector, followed by transport and residential. Most of the decline in energy use is due to decreased consumption in industry, which is reflected in a similar decline in GHG emissions (Box 4.1 and Figure 4.3). Energy use in the residential, commercial and public sectors grew in the second half of the 2000s. Nonetheless, overall GHG emissions from residential and commercial buildings declined, owing to fuel switching and greater use of district heating (Box 4.1, Section 6.2). Consumption in the transport sector grew by 11% since 2000, but the progressive shift to biofuels and lower-emission vehicles has helped mitigate GHG emissions (Section 8).

Figure 4.9. **Energy intensity and use**



a) Total primary energy supply per unit of GDP (2005 prices and purchasing power parities).
Source: IEA (2013), *IEA World Energy Statistics and Balances* (database); OECD (2013), *OECD Economic Outlook No. 93* (database).

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Sweden's energy efficiency policy works within the context of EU directives and regulations.[22] They set the overall objectives or policy, a framework for monitoring and reporting of progress through periodic national energy efficiency action plans (NEEAPs), and technological specifications in several areas. Sweden has a number of objectives for energy efficiency policy, including saving energy by 9% compared with the 2001-05 average

by 2016, and cutting energy intensity by 20% between 2008 and 2020 (Table 4.1). Sweden expects to achieve 15% energy savings by 2016, thereby exceeding its target (Government Offices of Sweden, 2011b). More effort is required to achieve the energy intensity target for 2020. Progress towards the energy intensity target will be assessed at a checkpoint in 2015.

Sweden has a long history of promoting energy efficiency improvements. Overall funding from the state budget in the area of energy efficiency is around SEK 530 million (EUR 61.44 million) per year. About half of this annual budget is managed by the Swedish Energy Agency through the energy efficiency programme (2010-14). The programme, adopted following the 2008/09 integrated energy and climate policy,[23] allocates SEK 1 350 million (EUR 156 million) over five years. It supports regional and local climate policy initiatives, green public procurement, and energy management, energy audit and procurement of energy-efficient technologies in small and medium-sized enterprises. The programme aims to overcome information and knowledge deficits in various sectors with a combination of independent, yet intertwined, measures and policy levers (IEA, 2013).

A broad range of policies and measures has been introduced across economic sectors to deliver the 2020 energy intensity objective. With the public sector expected to take the lead role, 180 public entities are required to save energy and report annually on their progress. The programme for improving energy efficiency in energy-intensive industry (PFE) has been the most important programme for the industrial sector. Introduced in 2004, it operates as a voluntary agreement between a company and the Swedish Energy Agency. Under the agreement, if a company commits to an energy management system, energy audits and other measures to increase efficiency, it receives an exemption from the energy tax on electricity (in total SEK 145 million per year). Overall, more than 100 companies (representing 75% of industrial energy use) participated in the PFE, invested SEK 708 million in energy efficiency measures and saved 1.45 TWh of electricity in 2004-08 compared to projections. However, as discussed in Section 5, exemptions from energy taxes distort price signals and may induce increased energy consumption, despite energy efficiency investments. Such exemptions undermine the cost effectiveness of Sweden's climate policy, and should be phased out rather than made conditional to the introduction of energy management systems or other energy efficiency measures (OECD, 2012).

Following the transposition of the EU Energy Performance of Buildings Directive, an energy performance certificate is required in Sweden whenever a building is sold, rented or constructed. In addition to strengthening minimum energy performance requirements for buildings, appliances and lighting, Sweden also promoted low-energy buildings. The Swedish National Board of Housing, Building and Planning adopted new energy standards for buildings that require a 20% improvement in energy performance.[24] These revisions have, to some extent, been prompted by ambitious building regulations introduced by leading municipalities. There is a tension, however, between allowing leading municipal authorities and/or regions to innovate with building regulations, and the requirement for a standardised approach across Sweden, which would reduce compliance costs for industry as a whole (Chapter 2). In 2010, Sweden launched the five-year LÅGAN programme to support demonstration projects in buildings with very low-energy consumption.[25]

There is a strong regional and local aspect to Swedish energy efficiency policy. Since January 1998, Swedish municipalities have been able to apply for state support to advise citizens on energy efficiency. Citizens of every municipality have access to a municipal energy and climate consultant. Since 2008, Sweden's CABs must produce regional

strategies for energy and climate issues, in collaboration with other regional and local actors. Strong co-ordination among the regional energy offices is ensured by the creation of the Energy Efficiency Council within the Swedish Energy Agency.

Overall, Sweden has a comprehensive energy efficiency policy mix. Price signals have been set through carbon and energy taxation, and the EU-ETS. These price signals are supported by targeted regulations, and the provision of information about energy use for both domestic households and businesses through various channels. Sweden is also among the first European countries to roll out smart metering to provide consumers with more accurate electricity bills. Information, training and dissemination tools are particularly strong at the local and regional level. Targeted R&D programmes are co-ordinated effectively by the Swedish Energy Agency.

However, the OECD survey of household behaviour indicates that Sweden scores the lowest in the energy-saving index among the 11 countries surveyed.[26] For example, almost 30% of Swedish respondents report they "never" or "occasionally" turn off lights when leaving a room (compared to 8% on average for the other countries); in Sweden, 45% of respondents report they "never" wash clothes in cold water, the highest level reported (OECD, 2013c). This suggests that Sweden should evaluate the results and synergies of the various energy efficiency measures and their contribution to achieving GHG emissions targets, as IEA (2013) recommended. This analysis would help prioritise and scale-up activities according to their potential for cost-effective and substantial energy savings.

8. Transport

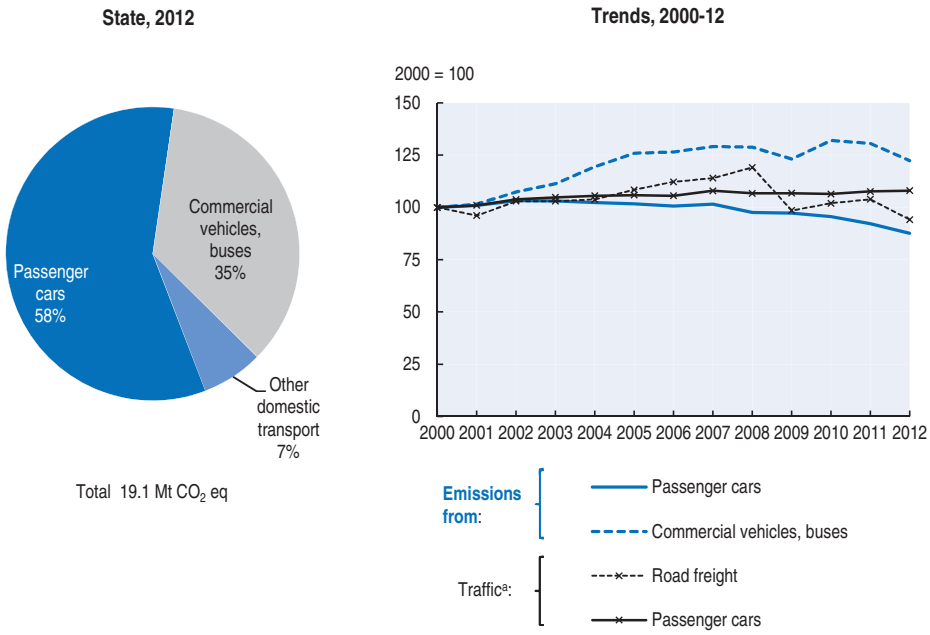
GHG emissions from the transport sector have declined in the second half of the 2000s, but transport remains the largest source of Swedish GHG emissions (Figure 4.3). Passenger cars accounted for 58% of transport-related emissions, followed by commercial vehicles and buses (Figure 4.10). Emissions from passenger cars declined 12%; this decline has been more rapid since 2007, mainly due to an increase in vehicle efficiency and biofuels use. Aggregate emissions from buses and commercial vehicles, however, increased 22% since 2000. This is due to economic growth and the increasing use of a few large centralised warehouses and factories, which results in goods being transported greater distances (Hedenus, 2008).

In 2013, a government commission submitted a report identifying possible measures to reduce GHG emissions from transport and achieve the goal of a transport fleet "independent" of fossil fuels by 2030 (Table 4.1). The research programme Northern European Power Perspectives found that Sweden could reduce fossil fuel use in transport by 80% by 2030 provided that additional policy measures are introduced (NEPP, 2013).

The Swedish renewable energy action plan (2010) foresees to achieve 13.8% of renewables in the transport sector (including biogas, ethanol, biodiesel and renewable electricity) by 2020. In 2012, Sweden reached a 12.6% share of renewables in transport, up from 4% in 2005;[27] it is therefore on track to meet its target (Table 4.3). The use of biofuels has delivered an estimated emissions reduction of approximately 0.4 to 1.1 Mt CO_2 eq per year in 2007-09, or around 1% of Sweden's GHG emissions (NAO, 2011).

A key driver of this trend is the exemption granted to biofuels from the energy tax and CO_2 tax. (Section 5). Sweden also introduced a number of measures to support sales of cars that can run on high-level blended ethanol (E85),[28] including exemptions from the congestion charge and motor vehicle tax (see below), cheaper parking fees and local

Figure 4.10. **Greenhouse gas emissions by the transport sector**



a) Based on data expressed in tonne/km and passenger/km.
Source: SEPA (2014), "Sa-mar-miljon - Fakta & statistik" [State of the Environment - Statistics & Facts], website; Trafikanalys (2014), *Transportarbete 1950-2012*, Statistik Portal.

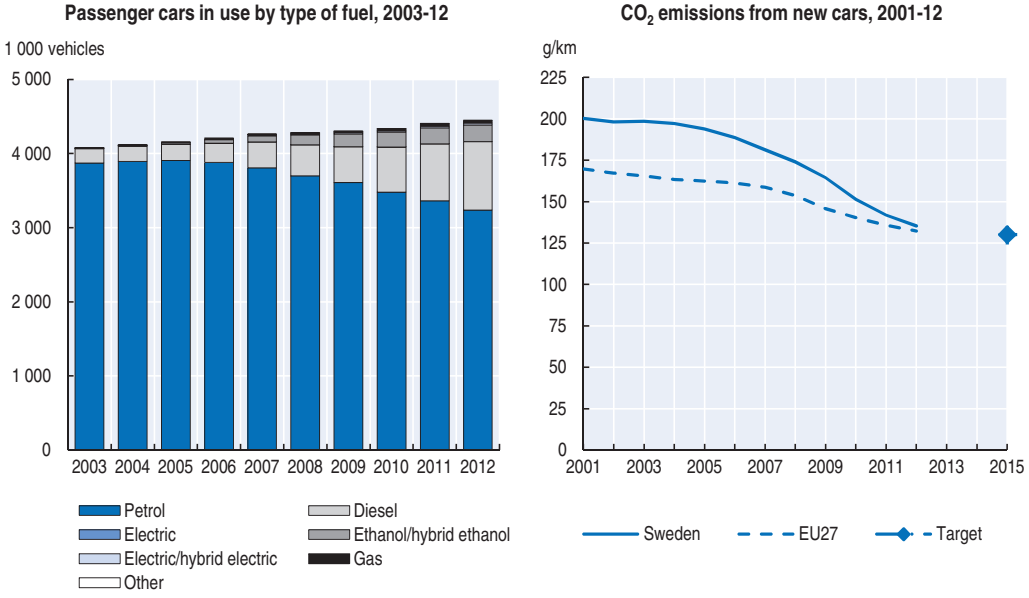
StatLink http://dx.doi.org/10.1787/888933145275

subsidies.[29] The 2006 Pump Act introduced an obligation to supply renewable fuels, thereby stimulating the development of biofuel distribution networks. As a result, the number of E85-adapted cars has grown (Figure 4.11) and Sweden was the first country in the EU to create a market for E85 (NAO, 2011). Finally, extensive state funding has been directed into research and development of biofuels in recent years. In 2009, another SEK 875 million over three years was allocated to R&D of vehicle biofuels.

However, Sweden's biofuel policy has been costly. Exemption from the energy tax is an expensive way of reducing emissions, costing the public budget about SEK 2 billion per year in lost tax revenue, or around SEK 3 000 per tonne of CO_2 reduction (NAO, 2011). In addition, the tax exemption is not sufficient to sustain consumption of E85 in periods of low fuel prices. This was the case in 2009, when many owners of E85-powered cars refuelled with cheaper petrol. Similar situations can result in higher GHG emissions because cars able to run on E85 have higher average fuel consumption than petrol cars (NAO, 2011).

In its Budget Bill for 2014, the government proposed to introduce the energy tax on biofuels used for low-blend purposes, although at a low rate so as not to discourage the use of low blends in the market. The tax is to be gradually adjusted to converge with the standard rate applied on fossil fuels. The exemption from the CO_2 tax would be retained. Starting in 2014, fuel companies must have a minimum percentage of renewable fuel in their petrol and diesel. This quota system seeks to double current standards to 10% for petrol and 7% for diesel. The exemption from both the energy and carbon taxes will be kept for high-level blended and pure biofuels outside the quotas.

Figure 4.11. **Composition of the car fleet**



Source: EEA (2013), *Monitoring CO_2 Emissions from New Passenger Cars in the EU: Summary of Data for 2012;* Trafikanalys (2013), *Vehicles Statistics*, Statistik Portal.

StatLink http://dx.doi.org/10.1787/888933145286

About 35% of Sweden's biofuels are imported. In 2010, following EU requirements, Sweden adopted the sustainability criteria for biofuels. Nevertheless, the environmental benefit of using biofuels for transport has been debated extensively in Sweden and internationally (Bowyer and Kretschmer, 2011). The impact of indirect land-use change of biofuels policy remains a concern. The European Parliament has been considering this issue and voted to cap the use of land-based biofuels to 6% of energy used in transport in the EU. How this issue plays out at the EU level could therefore have an impact on Sweden's biofuels policy.

The efficiency of new cars has also increased rapidly. The average CO_2 emissions from new cars sold in 2012 were 135.4 g CO_2/km in Sweden (Figure 4.11). While this remains slightly above the EU average of 132.2 g CO_2/km, it is a reduction of 25% since 2007 (EEA, 2013b). This can be directly attributed to changes in the composition of the car fleet: there is an increasing share of diesel cars, which are more fuel efficient, but emit more local air pollutants (namely particulate matter and nitrogen oxides) (Figure 4.11). The efficiency of new vehicles has been driven by new EU emission performance standards,[30] subsidies for the purchase of "green" cars and "super-green" cars,[31] and by amendments to the vehicle tax system.

Since 2009, the Swedish vehicle taxation system has supported the purchase of "green" vehicles, through exemptions granted for a period of five years upon first registration. The tax comprises a basic amount of SEK 360/year, and an additional component based on CO_2 efficiency (SEK 20 g CO_2/km over 117 g CO_2/km). The CO_2-based component is halved for vehicles that run on renewables, while the total tax is multiplied by a fuel factor of 2.33 for cars that run on diesel fuel. To some extent, this offsets the lower energy tax rate on diesel. The "new car guide" and the "car calculation" help individuals choose a car that has less impact on the climate; eco-driving is part of the driving licence

test. Since 2005, environmental requirements have also been in place for the procurement of cars, rental cars and taxi trips by public institutions and agencies; for company cars, rules allow for a reduction of the taxable fringe benefit value for environmentally friendly cars. However, company cars, which represented 48% of new car registrations in 2009-11, remain generally bigger and less CO_2-efficient than other cars. This is partly as a result of their relatively favourable tax treatment (Chapter 3).

In 2007, after a trial period and referendum, a congestion charge was introduced in Stockholm. A charge of between EUR 1.0 and EUR 2.0 is imposed for passing a toll cordon around the inner city on weekdays, depending on the time of travelling (the charge is higher at peak hours). The congestion charge has contributed to reducing city centre traffic. Börjesson et al. (2012) estimate that, over time, the charges have caused traffic to decrease slightly; in 2011, traffic was about 20% below the 2005 level (before the charge was introduced). While public opposition to the charge was considerable, this was also found to diminish over time. In January 2010, the municipality of Gothenburg decided to follow the example of Stockholm by introducing a congestion charge in the city centre beginning in 2013. Locally, municipalities also have an impact on car use through parking rules and charges.

In contrast to the comprehensive package of measures introduced to address emissions from passenger vehicles, few initiatives have been introduced in the freight sector. Compared to other European countries, Sweden transports a large portion of freight by rail and shipping (64% of domestic and international freight haulage). However, heavy goods vehicles account for the largest share of domestic freight, mainly on long-distance hauls. The greater flexibility of road transport and the insufficient availability of rail services have hampered shifting from road to rail (Hedenus, 2008). Cost of road transport remains too low for other transport modes such as rail and sea shipping to be competitive.

The prices of road freight transport do not fully include the costs to society, including costs associated to emissions of GHG and local pollutants (Trafikanalysis, 2013). Fuller internalisation of the costs of transport could induce better logistics management, promote fuel-efficient driving practices and make alternative modes (rail and sea) more competitive. This, in turn, will increase the efficiency of the transport system. Introducing distance- and emission-based road tolls for heavy goods vehicles, as for example in Germany (OECD, 2012), could help achieve these goals. Analysis suggests the few negative effects on employment and on some businesses in northern Sweden would be relatively minor (SIKA, 2007). Training in eco-driving also has the potential to reduce fuel consumption significantly (Hedenus, 2008).

International travel also has a significant environmental impact. GHG emissions from international sea shipping and aviation by the Swedish population and companies totalled about 8 Mt CO_2 eq in 2012, of which 27% stems from air travel. Since 1 January 2012, aviation has been included in the EU-ETS, but the impact on emissions is small due to its restricted application[32] and the low price of emission allowances. Sweden could consider other options to price the externalities associated with air transport, such as a charge on air passengers' travel with tax rates varying with the distance of the flight as implemented in Germany (OECD, 2012).

The Swedish government requires the development of transport infrastructure to be "consistent with the established climate and environmental objectives". However, Finnveden and Åkerman (2011) found this is not the case for the national infrastructure

plan 2010-21 and the planning of Bypass Stockholm (a major road investment). NAO (2013b) found that the profitability of many infrastructure projects depends upon the assumption of increasing traffic volumes, which is in conflict with the climate objectives. It also found that GHG emissions resulting from the national infrastructure plan have been underestimated. Consequently, NAO (2013b) recommended that government should establish an approximate trajectory for reduced transport emissions consistent with climate objectives (in connection with the climate roadmap for 2050), and identify a division between modes of transport consistent with meeting this trajectory.

9. Adaptation to climate change

While Sweden does not have an overarching strategy for climate adaptation, the 2008/09 Climate Bill includes strategic considerations and measures to adapt to a changing climate. Much work has been undertaken to understand the impacts of climate change and to address these impacts, for example by implementing landslides and flooding prevention measures. The Swedish Commission on Climate and Vulnerability (2007) analysed the country's vulnerability in the face of future climate change. The inquiry identified many damages, including the following: increased risks of flooding and coastal erosion; increased damage to forests; higher costs for cooling commercial premises and homes; higher costs for supplying drinking water; and more heat-related deaths. The inquiry also mentions several positive effects of climate change on the economy. These include: lower heating costs; increased production of hydroelectric power; and increased growth of forests. Assuming an annual GDP growth of 2%, the estimated costs are equivalent to about 0.2% of GDP both in 2050 and 2100 (Swedish Commission on Climate and Vulnerability, 2007). The costs and benefits of climate change are estimated to be about the same. Other estimates indicate an overall positive economic impact of climate change in Sweden, similarly to other Nordic countries, of about 1.4% of GDP by 2030 (Fiscal Policy Council, 2013).

In the 2009 Climate Bill and in the 2011 and 2012 Budget Bills, the Swedish government outlined a proposal for climate adaptation that delegated a central role to the regions. CABs are required to draft action plans to co-ordinate work on the regional level, starting with an assessment of climate change vulnerability. This includes compiling, reporting and drawing comparisons between climate adaptation work undertaken in the municipalities. Several CABs and municipalities have drawn up risk and vulnerability analyses.[33] The CABs report annually to the Ministry of the Environment about the actions taken to adapt to climate change. The Swedish Portal for Climate Change Adaptation, a website that provides information about possible adaptation measures, is the result of co-operation between 14 national agencies working with the Swedish Association of Local Authorities and Regions. In 2012, a national knowledge centre for climate change adaptation was set up at the Swedish Meteorological and Hydrological Institute, to support the adaptation work. However, with a few exemptions, environmental assessment of long-life investments such as infrastructure projects do not systematically take into account the risks associated with climate change (e.g. extreme weather events) and the need to implement preventive measures to mitigate such risks.

No overall assessment of the cost effectiveness of Sweden's work on climate change adaptation has been performed. The Swedish Meteorological and Hydrological Institute will review climate change adaptation work as part of a climate policy control station in 2015. As this work progresses, the case for an overarching strategy for climate change

adaptation in Sweden may emerge. A national strategy could deliver guidelines based on best practice in the regions to ensure quality and consistency of plans. A national plan could also facilitate the development of a more robust and comprehensive evidence base around the key risks and opportunities posed by climate at a national level, the costs and benefits of action in various areas and priority actions within constrained budgets. In addition, Sweden could consider extending the use of insurance to reduce the burden of extreme weather events on the public budget and on individuals.[34]

Notes

1. Commission decision of 14 December 2006 determining the respective emission levels allocated to the Community and each of its member states under the Kyoto Protocol pursuant to Council decision 2002/358/EC.
2. Climate and Energy Bills 2008/09:162 and 163.
3. The Swedish government adopted a target for the non-ETS sector alone, in contrast to, for example, the UK and German governments' targets for 2020, which apply to total national emissions.
4. Decision No. 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of member states to reduce their GHG emissions to meet the Community's reduction commitments up to 2020.
5. A carbon sink credit is available to Sweden of 2.13 Mt CO_2 eq per annum according to articles 3.3 and 3.4 in the Kyoto Protocol, for the purpose of Kyoto compliance, although its use is unnecessary to meet the Kyoto target (SEPA, 2013b).
6. The ESD imposes a legally binding annual emission allocation for each year in the period to 2020. See Commission decision of 26 March 2013 on determining member states' annual emission allocations for 2013-20 pursuant to decision No. 406/2009/EC of the European Parliament and of the Council.
7. Measures to reduce emissions in the agriculture sector in Sweden are generally proscribed by the EU Common Agricultural Policy. The Swedish Board of Agriculture has drawn up an action programme to reduce nutrient losses and GHG emissions from agriculture. Further restrictions on the spreading of fertilisers were introduced in 2010 (Ministry of the Environment, 2013).
8. Parliamentary Climate Committee report M2007/03 in the case of the 2009 climate strategy.
9. For transport projects, the recommended shadow value for a tonne of CO_2 eq emitted varies between SEK 1 080 (the current carbon tax rate), for short-term projects, and SEK 2 180, for long-term ones (to 2050) (Swedish Transport Administration, 2012).
10. In the case of the UK this is required by the UK Climate Change Act (2008). Ireland had carbon budget statements in Parliament as a matter of parliamentary procedure in 2010 and 2011; a 2013 legislative proposal under discussion at the time of writing introduces mandatory annual statements before the Irish Parliament.
11. Economic theory indicates that a cost-effective policy mix should equalise marginal abatement costs across all emission sources to fully exploit existing opportunities for low-cost GHG emission reductions (OECD, 2009).
12. The combustion of peat in approved CHP plants has also been supported under the Swedish electricity certificates system for promoting renewable energy and peat since 1 April 2004 (Section 6.1).
13. On the one hand, this estimate does not take into account exemptions that lower the impact on emissions. On the other hand, it does not include the impact of the energy tax on GHG emissions. Furthermore, the extrapolation assumes a linear relationship between the CO_2 tax and emission reductions (Jamet, 2011).
14. The EU-ETS Directive (2003/87/EC) required participating countries to prepare national allocation plans for the first and second trading periods. Each plan determined the number of emission allowances available for the participating sectors, the number of allowances allocated for free to each installation and the number of allowances to be auctioned.
15. In addition, about 5% of the total ETS cap for the second trading period was auctioned.

16. If companies sell their allocated allowances, the revenue is taxed, which reduces the value of the allowance surplus (NAO, 2012).
17. Initially set at 150% of the market price.
18. Total costs break down as follows: 45% borne by households, 29% by the service sector, 17% by the industry sector and 9% by the transport, agriculture and district heating sectors (IEA, 2013).
19. Plants commissioned before the certificate system was introduced are entitled to certificates only until the end of 2012; plants that received a public investment grant after 15 February 1998 are entitled to certificates until the end of 2014.
20. A third of the total funds (approximately SEK 1.0 billion) of LIP were allocated to investments in the sustainable energy sector, and these were particularly successful in promoting the utilisation of industrial waste heat (Ericsson, 2009). LIP investments are estimated to have reduced emissions by up to 1.5 Mt CO_2 eq annually (SEPA, 2004).
21. According to manufacturers, an export sector was also created, with between 40% and 50% of production exported (Kiss et al., 2012).
22. The most important of which are: the Energy Efficiency Directive (2012/27/EU), the Co-generation Directive (2004/8/EC), the Energy Services Directive (2006/32/EC), the Energy Performance of Buildings directives (2002/91/EC; 2010/31/EU), the Eco-design directives (2005/32/EC; 2009/125/EC) and the Energy Labelling Directive (2010/30/EU).
23. The energy efficiency component was based on the proposal from a parliamentary energy efficiency inquiry.
24. A minimum energy performance standard of 90 kWh/m^2 in the south and 120 kWh/m^2 in the north is required.
25. The project is a collaboration among the Swedish Construction Federation, the Swedish Energy Agency, the Swedish Research Council and the Region Västra Götaland.
26. The surveyed countries are: Australia, Canada, Chile, France, Israel, Japan, Korea, the Netherlands, Spain, Sweden and Switzerland. The energy-saving index aggregates the answers to the question "How often do you perform the following in your daily life?", where the energy-saving activities are: turn off lights when leaving a room; cut down on heating/air conditioning to limit energy consumption; only run full loads when using washing machines or dishwashers; wash clothes using cold water (e.g. 30°C); turn off stand-by mode of appliances; and air-dry laundry rather than using clothes dryers. A score was generated for each of these six activities, with 0 being the score associated with "never", 1 with "occasionally", 2 with "often" and 3 with "always". The scores for each of these behaviours were then added up into an aggregate score, which was rescaled to have mean zero and standard deviation equal to one (OECD, 2013c).
27. Especially low-blend ethanol in petrol and hydrogenated vegetable oils and rapeseed methyl ester in diesel (IEA, 2013).
28. E85 is a fuel consisting of 85% ethanol and 15% petrol.
29. The total cost of these measures can be estimated at SEK 300 million per year (NAO, 2011).
30. CO_2 emissions of new passenger cars may not exceed 130 g CO_2 per km by 2015 and 95 g CO_2 per km by 2020 (Regulation (EC) No. 443/2009). The emission limit for new vans is 147 g CO_2 per km in 2020 (Regulation (EU) 510/2011).
31. Until 2012, a green vehicle was defined as one equipped with technology for operation entirely or partially on electricity, alcohol or gas, or a fuel-efficient petrol or diesel car with CO_2 emissions below 120 g/km. In January 2013, a tighter definition was introduced that takes into account the weight of the car based on the EU legislation on CO_2 limits for new passenger cars. A super-green car is defined as a vehicle with CO_2 emissions below 50 g CO_2/km.
32. In April 2013, the EU decided to temporarily suspend enforcement of the EU-ETS requirements for flights operated in 2010, 2011 and 2012 from or to non-European countries; it continued to apply the legislation to flights within and between countries in Europe. In October 2013, the International Civil Aviation Organization (ICAO) Assembly agreed to develop by 2016 a global, market-based mechanism addressing international aviation emissions and apply it by 2020. Until then, countries or groups of countries can implement interim measures.
33. See, for example, the analysis from the counties of Norrbotten and Värmland.

34. In 2005, the storm Gudrun caused damage to forests equivalent to 0.5% of GDP. The government spent SEK 3 billion to compensate forest owners, most of which were uninsured, for their economic losses (Fiscal Policy Council, 2013).

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PART II

Chapter 5

Marine ecosystem services

The marine environment is particularly important for Sweden, one of the nine Baltic Sea countries. This chapter describes the ecosystem services that several economic sectors obtain from the marine environment. It examines the pressures on Sweden's marine environment and the status of marine ecosystems, habitats and species. The chapter describes Sweden's institutional and policy framework for the conservation and sustainable use of the marine environment. Finally, it presents how the ecosystem approach is integrated into Sweden's marine policy, including through marine spatial planning and protected areas.

Assessment and recommendations

The marine environment is particularly important for Sweden, one of the nine Baltic Sea countries. Several economic sectors (including shipping, fishing, coastal industry and tourism) obtain direct economic benefits from the marine environment and contribute to Sweden's economy and employment. However, they also exert pressures on ecosystems. There is increasing evidence of the vulnerability of the Baltic Sea; despite significant efforts, progress in combating eutrophication, pollution from toxic substances and overfishing has been limited; and new pressures are emerging, including climate change, ocean acidification and invasive alien species. All this has led Sweden to increase attention to the management of marine ecosystem services in recent years.

Sweden has actively engaged in international initiatives to strengthen the management of the marine environment, notably within the European Union (EU), the Baltic Marine Environment Protection Commission (HELCOM) and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR). There has been increasing recognition, nationally and internationally, that an ecosystem approach is needed to ensure conservation and sustainable use of marine ecosystem services. It provides a more holistic, and ultimately more effective, approach for managing the impacts of diverse activities and sectors on the marine environment.

Implementing this new approach requires appropriate institutions. The establishment of the Swedish Agency for Marine and Water Management (SwAM) in 2011 is a first step towards a more coherent and integrated approach to managing marine and water environment. SwAM is responsible for developing and implementing a sea-basin based strategy for Sweden's marine waters in line with the Marine Strategy Framework Directive. This provides an opportunity to streamline the main marine programmes and improve coherence with policies in other sectors.

Policies in sectors such as agriculture, fisheries, tourism and transport have the potential to both intensify and alleviate pressures on the marine environment. For example, the exemption of fisheries from the fuel tax can encourage large-scale fisheries. At the same time, a variety of grants are provided to fishers for the protection and sustainable use of fish stocks. More could be done to take account of the conservation and sustainable use of marine ecosystems as sectoral policies and programmes are being prepared.

The vast array of activities that exert pressures on the marine environment require a wide range of management measures. Among these measures are marine protected areas (MPAs). Sweden has extended the marine areas under protection, including within the EU Natura 2000 network and the Baltic Sea protected areas system. Currently, 6.3% of territorial waters and exclusive economic zones are protected. Sweden will need to expand the coverage of MPAs to meet the Aichi target of protecting at least 10% of coastal and marine areas by 2020. It should also ensure that all MPAs have management plans and the means to implement them. In 2009, Sweden established its first marine national park in

Kosterhavet. It provides a good model for similar initiatives, based on the effective participation of local communities in decision making.

Marine spatial planning directs the use of marine waters and identifies areas best suited for competing activities. Sweden has participated in pilot marine spatial planning projects for the Baltic Sea, or parts of it, under the aegis of HELCOM. This provides a good basis for implementing the proposed EU directive on maritime spatial planning. While Sweden lacks a process for integrated coastal zone management, its approach to shore protection has helped preserve the coastal environment. However, coastal zone management is the responsibility of municipalities, while marine spatial planning is the responsibility of central authorities. To date, only a few of the 85 coastal municipalities have included marine areas in their comprehensive spatial plans. This highlights a lack of an integrated approach to the spatial planning of coastal and marine waters.

Some recent analyses suggest the costs of achieving marine environmental targets (such as reducing nutrient load) are substantial, underlining the importance of implementing cost-effective approaches. Market-based instruments can help in this regard, and Sweden has implemented several to improve the marine environment. These have included wastewater pollution charges, a tax on pesticides, a tax on mineral fertilisers containing nitrogen (removed in 2011), pollution charges on oil spills and shipping lane duties. There is some evidence these measures have been cost effective, for example, in reducing leaching of nitrogen. Sweden has limited experience with the use of payment for ecosystem services (PES) in marine areas. One possible approach involves using mussel farms to remove nutrients discharged by local wastewater treatment plants. There is scope to expand the use of PES programmes and economic instruments, such as the proposed trading scheme for discharges of nitrogen and phosphorous to combat eutrophication. This would be more effective if it were implemented with partners around the Baltic Sea.

Sweden has pursued economic opportunities presented by the 'blue economy'. Marine issues were included in the 2012 innovation strategy. The focus on the conservation and sustainable use of marine ecosystems could be further strengthened in the context of innovation policy, and in discussions about a European blue economy strategy.

Like many other countries, Sweden is at a very early stage in implementing the ecosystem approach in its marine policy. Most ecosystem service evaluation studies have targeted limited areas. Despite considerable progress, there are still important data gaps. Data collection and monitoring of ecosystems, populations and species should be strengthened to provide a better baseline, to identify changes over time and to establish a better scientific basis for assessing proposed measures. A major challenge is how to assess cumulative impacts in large complex ecosystems, and how to identify any thresholds that may result in irreversible changes. This includes developing a better understanding of the impacts of climate change and ocean acidification. As scientific understanding improves, the economic evaluation of marine ecosystem services should be strengthened to better support policy makers in identifying priorities and addressing trade-offs.

Recommendations

- Develop an overarching national water and marine strategy to integrate national and regional activities, in line with the requirements of the EU Marine Strategy Framework Directive.
- Prioritise and take steps to fill data gaps, particularly those related to measuring and monitoring the status of marine ecosystem services and water; and strengthen the economic evaluation of marine ecosystem services.
- Ensure that climate change adaptation programmes take account of the sustainable use of marine ecosystem services, including the impacts of ocean acidification.
- Systematically review the opportunities and threats to marine ecosystems posed by policy measures in other sectors (e.g. fishing, agriculture, transport, tourism); integrate the sustainable use of marine ecosystems into tools, such as strategic environmental assessment, used to screen the potential environmental impacts of sectoral policies and programmes.
- Further expand marine protected areas (MPAs) with a view to meeting the Aichi target by 2020; establish effective management plans for all MPAs and allocate adequate resources to implement them; and assess the potential of market-based instruments (e.g. marine biodiversity offsets) to help finance the management of MPAs.
- Better integrate, and improve the coherence of, marine spatial planning and coastal zone management.
- Further develop payment for ecosystem service programmes and extend the use of market-based approaches for reducing marine pollution, especially from nutrients and hazardous substances, e.g. through trading systems for nitrogen and phosphorous discharges.
- Ensure the sustainable use of marine ecosystem services is fully integrated into Sweden's innovation and enterprise policies; and co-operate with EU partners to make sure the EU blue growth strategy adequately incorporates the ecosystem approach.

1. Marine ecosystem services in Sweden

Ecosystem services are "the benefits people obtain from ecosystems" (Box 5.1), such as food, water, genetic resources, the regulation of climate and water quality, soil formation and pollination, as well as recreation and aesthetic enjoyment (Millennium Ecosystem Assessment, 2005). The services and benefits marine ecosystems provide to society depend on how well those ecosystems function.

Box 5.1. **Ecosystem services**

Ecosystems are the basis of human life and contribute to human well-being in numerous ways. A well-functioning ecosystem typically provides society with a variety of goods and services. These services can be classified as final or intermediate services. Final services link directly to human welfare, such as fish stocks for food, clear water for recreation and waterways for shipping. Final services depend on intermediate services such as food webs and biodiversity, air and climate regulation, and overall resilience (European Commission, 2010). Ecosystem services can be divided into four categories: provisioning, supporting, regulating and cultural services (Millennium Ecosystem Assessment, 2005).

The understanding of marine ecosystem services and water is particularly important for Sweden, one of nine Baltic Sea countries (Figure 5.1). The Baltic Sea[1], the largest body of brackish water in the world, contains a mixture of saline seawater from the North Sea and freshwater from rainfall and rivers seeping from a catchment area four times larger than the sea itself (SEPA, 2009). As the Baltic Sea is a semi-enclosed estuary connected to the Atlantic through the North Sea via the narrow and shallow Danish Straits, water exchange and salt water inflow are very limited. Biodiversity is low as the few species that have adapted to live in brackish water are more sensitive to changes in salinity range than saltwater and freshwater

Figure 5.1. **The Baltic Sea and its freshwater catchment area**

Source: SEPA (2009), *What's in the Sea for Me? Ecosystem Services provided by the Baltic Sea and Skagerrak*, Report Number 5872.

species. For example, fish stocks have an uneven distribution. Biodiversity is higher in the Skagerrak sea, where the number of species is nearly ten times higher than the number of species found in the Baltic (SEPA, 2009).[2] The Baltic Sea suffers from serious environmental problems that have an economic impact; many of Sweden's coastal and marine areas are badly affected by eutrophication, hazardous substances, overfishing and exploitation (Section 3). Almost one-third of all red-listed species in Sweden are associated with aquatic environments, including freshwaters (SEPA, 2009).

Table 5.1 lists a number of marine ecosystem services provided by the waters surrounding Sweden.

Table 5.1. **Marine ecosystem services provided by the Baltic Sea, the Skagerrak and the Kattegat**

Ecosystem service	Definition
Provisioning services	
Food	Fish, shellfish, algae
Inedible goods	Sand, rocks, oil, industrial water
Genetic resources	Marine genetic resources of actual or potential value
Chemical resources	Pharmaceutical, chemical and biochemical use
Ornamental resources	Seashells, driftwood, amber
Energy	Wave energy
Space and waterways	The sea surface as a medium for transport, construction
Regulating Services	
Climate and atmospheric regulation	Absorption of carbon dioxide and production of oxygen
Sediment retention	Mitigating coastal erosion
Eutrophication mitigation	Removal of excess nitrogen and phosphorus
Biological regulation	Regulating the abundance of other organisms e.g. pests and pathogens
Regulation of hazardous substances	Breaking down, storing and burying of toxic substances and societal waste
Supporting services	
Biogeochemical cycling	Nutrient, carbon, oxygen and water cycles
Primary production	The conversion of dead material (inorganic) to living material (organic) by means of photosynthesis
Food web dynamics	The trophic relationships among organisms
Biodiversity	The variety of genes, species, ecosystems and ecosystem functions
Habitats	The environment in which organisms live
Resilience	The extent to which ecosystems can absorb changes and continue to regenerate without degrading
Cultural services	
Recreational activities	Tourism, swimming, boating, fishing, bird watching
Scenery	Scenery, clear water, beauty and silence
Science and education	Educational activities and research
Cultural heritage	Historic shipwrecks, coastal communities, fishing villages
Inspiration	Art, literature, music, films, advertising
Legacy	Preservation of nature

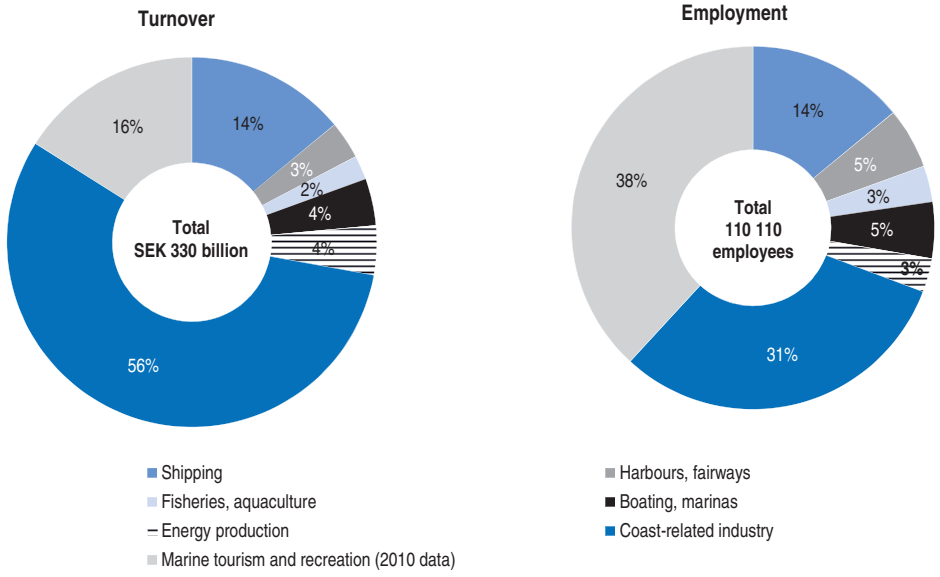
SwAM (2012), *An Ecosystem Service Approach for Analyzing Marine Human Activities in Sweden, A Synthesis for the Economic and Social Analysis of the Initial Assessment of the Marine Strategy Framework Directive*.

2. The value of marine ecosystem services in Sweden

2.1. *Direct economic benefits from using marine ecosystem services*

Statistics Sweden has identified the following sectors that obtain a direct economic benefit from the use of marine ecosystem services: shipping, harbours and fairways/ waterways; fisheries and aquaculture; marine tourism and recreation, boating and marinas; museums and education; energy production and mining; industry with direct load to the sea; anti-flooding; construction, land use and defence, science and education (Ministry of the Environment and SwAM, 2013). Possible indicators of importance for assessing the direct economic benefit of using marine ecosystem services are: value added, production value, income and employment (Figure 5.2).

Figure 5.2. **Turnover and employment in the maritime sector in 2009**



Source: SwAM (2012), *God havsmiljö 2020.*

Marine-related sectors account for an important share of Sweden's total turnover and employment.[3] Turnover for maritime activities was about SEK 330 billion (Swedish krona) in 2009, representing 5.2% of the total private sector (excluding financial services) and 4.5% of total employment. The coastal industry dominated sales (56% of total turnover).[4] The transport industry alone (shipping, harbours and fairways) represented 17% of the maritime sector's total turnover (Figure 5.2). The maritime sector also includes offshore activities such as ocean transportation and oil extraction. Approximately 150 companies with a total turnover of SEK 1 billion are involved in this sector (SwAM, 2012a).[5]

Shipping, harbours and fairways

The Baltic Sea is one of the busiest seas in the world with around 2 000 ships in the marine area at any given moment. Both the number of ships and the quantity of cargo are growing rapidly. Sweden's five largest ports in terms of cargo volume are Gothenburg, Brofjorden, Trelleborg, Malmö and Luleå, which together handled around half of the total weight of goods in Swedish ports in 2009 (Trafikanalys, 2011).

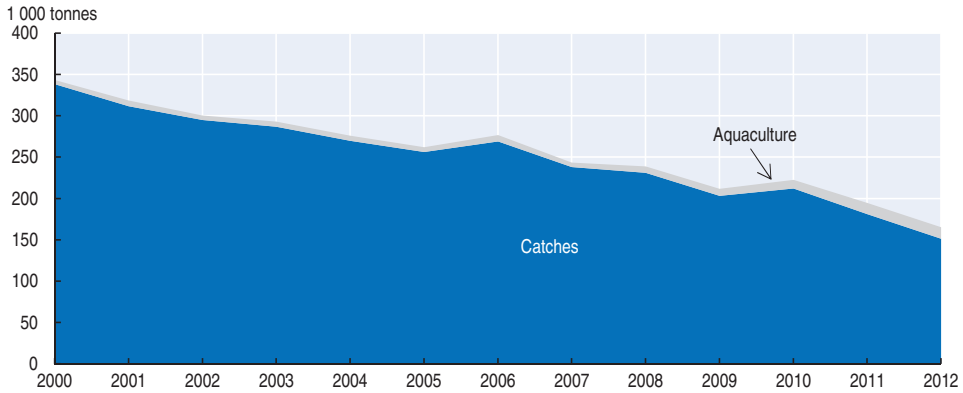
The Skagerrak, the Kattegat and the Danish Straits are the main route for freight between the North Sea and the Baltic Sea, providing access to the majority of Sweden's 50 public ports. Sweden's largest ports in terms of cargo volumes are on its west coast. To maintain and build new harbours and fairways, dredging is required. In 2010, companies in the water construction and engineering sector generated a turnover of SEK 873 million (Ministry of the Environment and SwAM, 2013).

Fisheries and aquaculture

Fisheries play social, ecological and economic roles that interact continuously and provide a range of ecosystem functions. In addition, traditional ways of fishing can be regarded as a cultural service. Fish also play an important role in sustaining the structure and function of ecosystems.

Sweden has fishing rights for 42 different stocks subject to regulations stemming from the European Union's Common Fisheries Policy (CFP). The most economically important species in Swedish commercial fisheries are herring and sprat, as well as cod, Norwegian lobster and shrimp, which accounted for around 85% of the landed value of fish caught by the Swedish fleet in 2009. Swedish vessels caught just over 150 000 tonnes of fish in 2012, or about 0.2% of world fish catches (Annex I.C); the catch has been declining since the late 1990s (Figure 5.3). The value of first sale was almost SEK 900 million (Ministry of the Environment and SwAM, 2013).

Figure 5.3. **Fish catches and aquaculture in Sweden in 2000-12**



Source: FAO (2014), *Global Capture and Aquaculture Production* (databases).

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The Swedish fishing, aquaculture and fish processing industries together are a small sector, accounting for around 0.1% of Swedish gross domestic product (GDP). Much of the fishing industry is still located in peripheral areas and is a significant contributor to rural livelihoods. Over 3 500 people were employed in the fishery sector in 2009: about half worked in fishing, with the remainder working in processing, manufacturing and development (Ministry of the Environment and SwAM, 2013).[6] Almost 80% of fishing turnover comes from fish processing. The sector comprises both small family businesses preparing fish from local catches, and large industrial enterprises that use local and imported fish (Döring and Guillen, 2010).

The aquaculture sector in Sweden is mainly comprised of small businesses with few full-time employees and large companies that are partly foreign-owned. Most businesses are located in rural areas and contribute significantly to local job creation and rural development. In recent years, the aquaculture industry has become increasingly concentrated. Now, the four largest companies account for around half of Sweden's total aquaculture production. In 2009, 208 companies were engaged in producing farmed fish, crabs, mussels and oysters, mostly in freshwaters (National Public Investigations, 2009). In 2011, total aquaculture production in Sweden was over 13 400 tonnes with a value of SEK 389.4 million (FAO, 2013).

Marine tourism and recreation

Marine tourism and recreation account for the largest share of employment in the maritime sector in Sweden (Figure 5.2). Coastal and marine tourism is worth 23% to 29% of total tourism in Sweden, whose turnover is SEK 255 billion (Ministry of the Environment and SwAM, 2013).[7] In addition, some 2 600 companies are engaged in recreational fishing with a total turnover of just under SEK 1 billion and about 2 000 employees (Ministry of the Environment and SwAM, 2013).[8]

Swedish residents own approximately 881 000 private boats; 46% have their homeport in Swedish marine waters. In 2010, sales in the recreational boating sector were estimated at about SEK 290 million for the North Sea and the Baltic Sea, excluding boats with homeports outside Sweden (Enveco Environmental Economics Consultancy et al., 2012). In 2010, there were 1 500 marinas in Sweden with just over half a million guest nights (by private boats registered in Sweden and abroad). Boat tourism is highly seasonal. The most common overnight accommodation is natural harbours, with an estimated 5 million guest nights in 2010 (Trafikanalys, 2011).

Energy production

Wind power has expanded significantly over the past decade. In 2012, production from wind amounted to 4% of Sweden's total electricity generation. Onshore wind power accounted for the greatest percentage of wind energy generation. There are currently three offshore wind farms in the Baltic Sea with permission recently granted for a wind farm in the North Sea. Total turnover of wind power production in Sweden was SEK 11 066 million in 2009, of which about SEK 200 million from offshore turbines (Ministry of the Environment and SwAM, 2013).

As nuclear power plants in Sweden use seawater as a coolant, they are classified as dependent on the sea. Nuclear power accounted for 38% of electricity generation in 2012. Turnover for nuclear power in 2009 was SEK 13 806 million (Swedish Radiation Safety Authority, 2013).

Inland sectors

Several inland sectors affect the marine environment through emissions in the form of organic material, nutrients and hazardous substances. The largest sources of nutrient loads are agriculture, municipal wastewater treatment plants and atmospheric deposition on surface water. As inland sectors affect marine ecosystem services but do not directly depend on them, they may not directly benefit from policies aimed at marine ecosystem service users. Nevertheless, inland sectors may incur the costs of compliance e.g. emissions control (Ministry of the Environment and SwAM, 2013).

2.2. Total value of marine ecosystem services

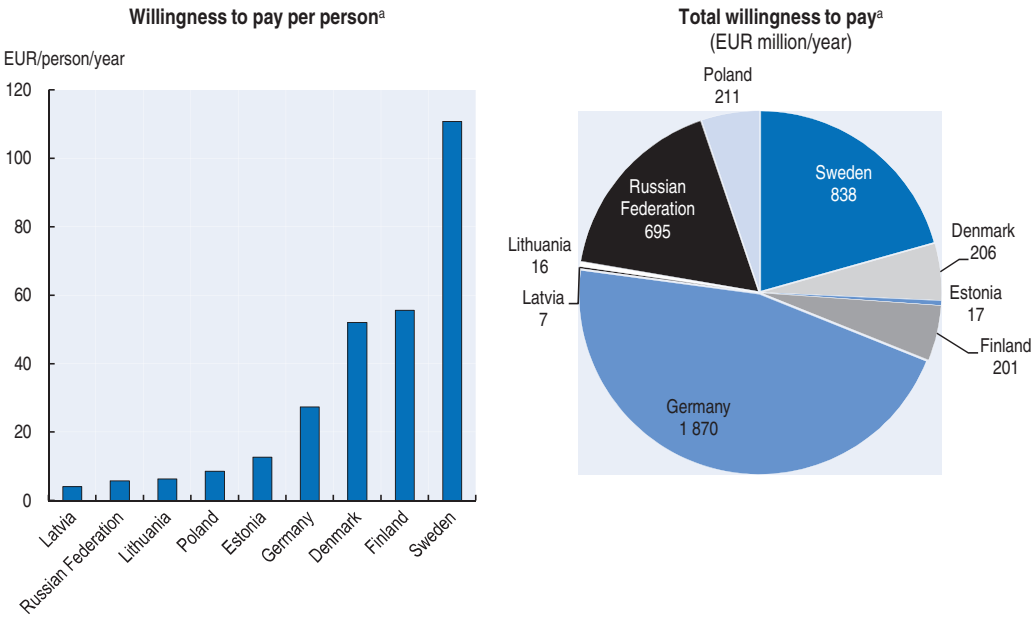
The government instructed the Swedish Environmental Protection Agency (SEPA) to synthesise the economic implications of human impacts on marine waters surrounding Sweden. In addition, seven background reports gathered existing material and involved experts from all countries bordering the Baltic Sea. The review included both user values and non-user values to better capture the total economic value of ecosystem services. It found approximately 40 studies on the economic value of marine ecosystem services provided by the Baltic Sea. These studies focused mostly on eutrophication (Box 5.2), fisheries[9], marine protected areas (MPAs)[10], recreational values and the location of wind turbines (SEPA, 2009). However, most dealt with a limited geographical area.

Box 5.2. **WTP in the Baltic Sea**

The only valuation study covering the entire Baltic Sea region uses a unique dataset collected from all nine littoral countries of the Baltic Sea, in combination with marine modelling to estimate the benefits of reducing eutrophication in the Baltic Sea. Based on approximately 10 500 responses (from a total population of 230 million) to identical questionnaires, respondents' willingness to pay (WTP) amounted to EUR 4 billion annually. Differences between WTP in various countries were large, with mean WTP per person being the highest in Sweden and lowest in Latvia (Figure 5.4). However, there is a general acceptance to pay more to improve the status of the whole Baltic Sea area in line with HELCOM Baltic Sea Action Plan (BSAP) levels (Section 5.3).

Source: Ahtiainen et al. (2012), "Benefits of Meeting the Baltic Sea Nutrient Reduction Targets – Combining Ecological Modelling and Contingent Valuation in the Nine Littoral States".

Figure 5.4. **Economic value of the Baltic Sea**



a) How much citizens of those countries have expressed they would be willing to pay for reducing eutrophication for a clean Baltic Sea.
Source: Havsmiljöinstitutet (2012), *Havet Rapporten 2012*.

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3. Status of Sweden's marine environment

3.1. *Environmental status of selected biological communities and functional groups*

Below, Table 5.2 indicates that the environmental status of selected biological communities and functional groups is mostly poor.

Table 5.2. **Environmental status of selected biological communities and functional groups**

	Skagerrak	Kattegat and Öresund	Baltic Proper	Bothnian Sea	Bothnian Bay
Phytoplankton	+/0	0	0	0	+
Zooplankton	?	0	0	0	+
Angiosperms	0	+	0/+	?	?
Macro-algae	0	+	0/+	+	?
Invertebrates	0	0	0	0	0
Fish	0	-	0	+/0	+/0
Mammals	0	0	0	0	0
Seabirds	?	0	0	0	0

Notes: + good environmental state
- bad environmental state
0 unacceptable environmental state
? no assessment made
Source: SwAM (2012), *God Havsmiljö 2020: Marin Strategi För Nordsjön Och Östersjön* [Good Marine Environment 2010: Marine Strategy for the North Sea and Baltic Sea].

Habitats

Of the 28 marine and coastal habitats included in the Habitats Directive, 18 occur in Sweden. From a national perspective, these habitats are evenly distributed. In terms of quality and future prospects, the status of most habitat types is not satisfactory due to eutrophication and overexploitation. Eutrophication is one of the severest environmental problems faced by the Baltic Sea.

While the depth distribution of macro-vegetation is generally good, its geographical distribution has decreased. This may be linked to eutrophication, as well as physical and biological disturbances. Initial assessments of soft-bottom macro-fauna show that species composition on the seabed of the Baltic and North Seas has changed significantly over the past century. These changes may be linked to the effects of eutrophication, physical impact and introduction of alien species. In some areas, new species have entirely supplanted earlier fauna (SwAM, 2012a). Sweden's share of marine red-listed species is greater than red-listed land species.

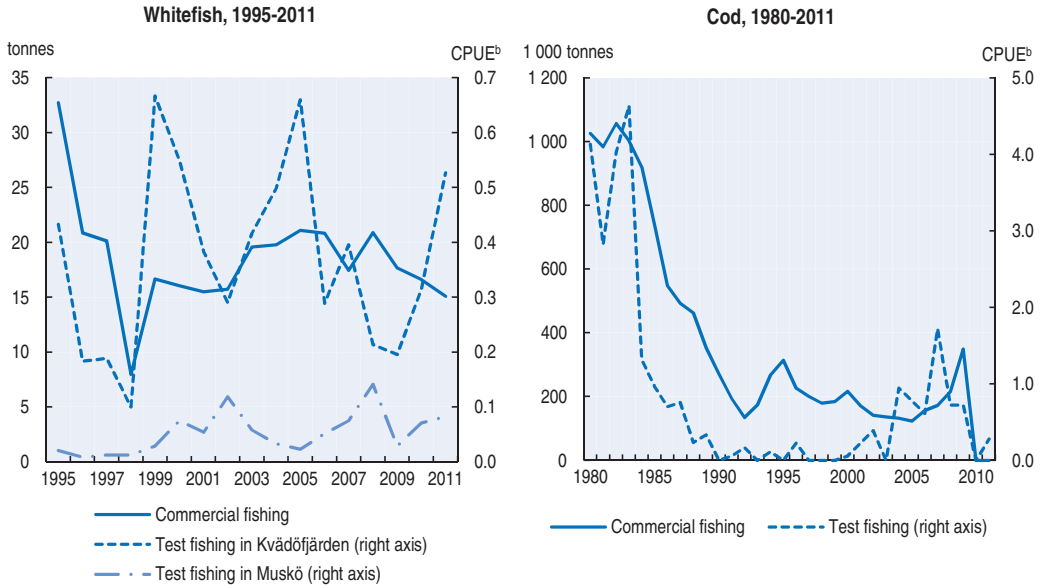
No national threat assessments of habitats are currently conducted in Sweden. In the HELCOM 2013 Red List of marine and coastal biotopes and habitats, 17 biotopes and habitats, as well as 8 biotope complexes, were listed as threatened, all of which occur in Swedish waters (HELCOM, 2013a). In the OSPAR list of threatened and declining species and habitats, 10 of the listed habitats occur in Sweden (OSPAR, 2008).

Fish and shellfish

Analysis of historical data shows significant and serious changes in stock structure over the 20th century along the west coast of Sweden; several local stocks are severely reduced or have disappeared. Downward trends in stock size are present for haddock, sole,

plaice and pollock; the spawning stock for Kattegat cod is at historically low levels; herring stocks have been decreasing since the mid-1980s (ICES, 2011); and the situation for eel is critical (SwAM, 2012a). Figure 5.5 shows that the cod stock has increased since 2005 in the Baltic Sea, although levels are still low compared to the 1980s. Whitefish is decreasing in the Bothnian Sea, but the stock in the Baltic Proper has been stable for 15-20 years (Havsmiljöinstitutet, 2012; SwAM, 2012a).

Figure 5.5. **Change in selected fish stock in the Baltic Sea**



a) Fish sampling for biological monitoring.
b) Mean fish catches per unit of effort in coastal fish monitoring areas.
Source: Havsmiljöinstitutet (2012), *Havet Rapporten 2012*.

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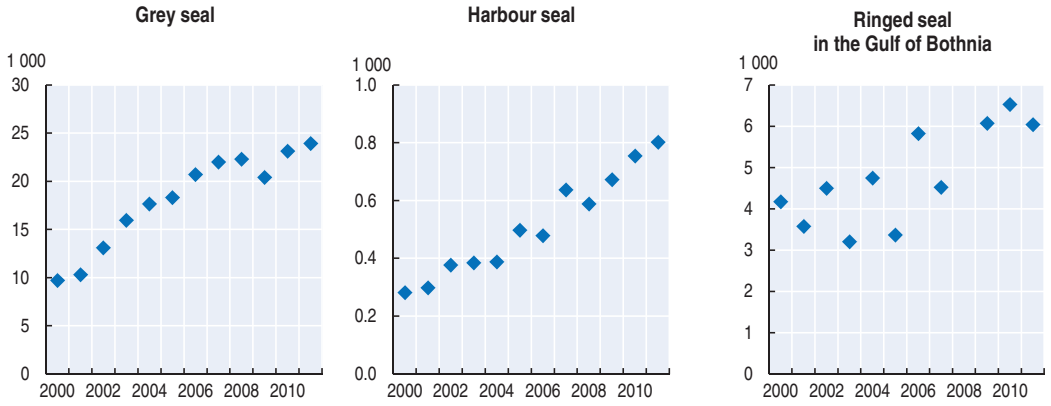
The 2010 Swedish Red List identifies 28 fish species in Swedish waters (Gärdenfors, 2010), while the OSPAR list of threatened and/or declining species includes nine fish species in the Greater North Sea, which includes Swedish waters (OSPAR, 2008).

Mammals

Grey seals, harbour seals, ringed seals and the harbour porpoise can all be found in Swedish waters. The situation of the three seal species has improved since the 1970s when they were critically endangered (Figure 5.6). The population growth rate of harbour seals in the North Sea is now normal, and ranks good for the grey seal population in the Baltic Sea. The population of ringed seals in the Gulf of Bothnia has a growth rate below expectations. The state of the porpoise is of continued concern, especially in the Baltic Sea.

Two marine mammals are found on the 2010 Swedish Red List. The ringed seal was classified as near threatened and the harbour porpoise as vulnerable. The porpoise population in the Baltic, a separate population with genetic and morphological differences compared to the porpoises in the North Sea, is classified as critically endangered. The largest threat is likely to be death from entanglement in fishing gear.

Figure 5.6. **Population of three seal species in the Baltic Sea and Sweden's west coast basin in 2000-11**



Source: Havsmiljöinstitutet (2012), *Havet Rapporten 2012*.

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Seabirds

As Sweden lacks a national inventory programme of nesting coastal birds, the state of knowledge about birds in the marine environment is highly heterogeneous. Existing inventory material on Swedish breeding birds over the past 30 years has been compiled in a database (Ministry of the Environment and SwAM, 2013). The presence of wintering water birds is relatively well documented in the context of national environmental monitoring, although longer time-series for offshore areas are lacking.

The state of birds was reported to the EU for the first time in 2013. Reporting includes national data for all species, as well as data regarding the prevalence of species listed in Annex 1 of the Birds Directive. In total, 31 bird species that occur in coastal, brackish or marine areas are listed on the 2010 Swedish Red List. For those coastal species where data are available, population development is generally positive, with some exceptions.

3.2. Pressures on marine ecosystems

A wide range of human activities impact on marine and water ecosystem services. Table 5.3 summarises key pressures on marine ecosystem services worldwide. Sweden has identified four major environmental stresses impacting the Baltic Sea and the North Sea: inputs of nutrients and organic matter, input of hazardous substances, biological disturbance and physical disturbance (SwAM, 2012a). Impact on the ecosystem services in the sea waters surrounding Sweden are considered so strong that even regulating services are under stress (SEPA, 2009). Although some services are relatively unaffected by environmental threats (such as the provision of space and waterways), others are impacted by many threats at the same time (such as biodiversity, habitats, food provisioning and recreation).

Overall, it is challenging to assess cumulative environmental effects in a large and complex ecosystem subject to many different pressures and with multiple and interactive components. It is also difficult to predict both human behaviour over time and the ultimate resilience of a marine ecosystem, particularly where there is a lack of data. Many processes and changes in the marine environment are slow, only becoming clear after a resilience threshold has been overstepped. Decreased resilience and ongoing threats could bring an

Table 5.3. **Drivers, threats and impacts on marine ecosystem services**

Driver	Threat	Impact	Marine ecosystem service affected
Land-based marine pollution sources	Nutrient emissions, hazardous substances	Algal blooms, reduced use of beaches, eutrophication, coastal pollution, erosion and dead zones, disrupted food chains	Primary production, biodiversity, habitat, resilience, climate regulation, sediment retention, eutrophication mitigation, regulation of hazardous substances, food, inedible goods, genetic resources, recreation, scenery, inspiration, legacy
Non-indigenous species	Infestations	Distributional ranges, infestations	Biodiversity, food web dynamics, genetic resources, habitat, resilience
Fisheries and aquaculture	Overfishing, nutrient emissions, bycatch, habitat disturbance, aquaculture	Reduction in available biomass, damage to ocean beds, habitat loss	Primary production, biodiversity, habitat, resilience, climate regulation, sediment retention, eutrophication mitigation, biological regulation, regulation of hazardous substances, food, inedible goods, genetic resources, recreation, scenery, legacy
Urban development (construction of piers, harbours, infrastructure and dredging operations)	Hazardous substances	Physical damage	Habitat loss
Climate change and ocean acidification	Ocean acidification, water temperature rise, decreased salinity, freshwater shortage	Reduced nutrient flows, shifts in marine life distributions, coastal erosion, flooding	Biogeochemical cycling, primary production, food web dynamics, biodiversity, habitat, resilience, climate and atmospheric regulation, food
Maritime transport	Shipping	Sewage, oil spills, hazardous substances, anti-fouling paint, invasive species	Primary production, biodiversity, habitat, resilience, climate regulation, sediment retention, eutrophication, regulation of hazardous substances, food, inedible goods, genetic resources, chemicals, recreation, scenery, inspiration, legacy
Marine tourism	Marine litter	Algal mats, cyanobacterial blooms, beach erosion	Primary production, biodiversity, eutrophication, regulation of hazardous substances, food, recreation, scenery, legacy

Source: OECD Environment Directorate.

ecosystem to a "tipping point" where thresholds are surpassed and regime shifts triggered, leading to unexpected outcomes such as new ecosystem states.

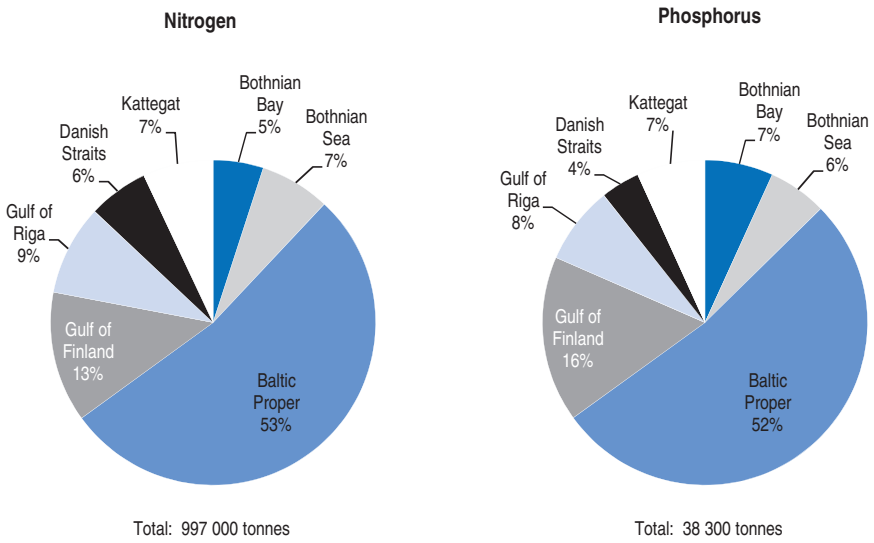
Land-based marine pollution sources

The marine ecosystem of the Baltic Sea is particularly vulnerable to pollution, due to limited water exchange and run-off from a catchment area containing 85 million people. Generally, no significant change of the region's population size is expected, although some coastal areas may experience a population increase due to migration and urbanisation (UNEP et al., 2005).

Increased loads of nutrients from agriculture, wastewater, industry and shipping are a major cause of eutrophication of the Baltic Sea (BalticSTERN Secretariat, 2013). Influxes of nutrients from industrial plants and sewage will likely diminish over time as existing policies take effect. However, problems caused by more widely dispersed and diffuse sources such as agriculture are less certain (SEPA, 2009; SwAM, 2012a). Increasing areas of

land under cultivation, extensive drainage of wetlands and lakes, and use of agricultural fertilisers all increase nutrient transport to the Baltic Sea, potentially leading to algal blooms, severe oxygen deprivation and "dead zones". Nutrient emissions from maritime transport and port activities are expected to increase up to 2020 and to a lesser extent up to 2050. Nutrient emissions from tourism, on the other hand, will likely increase up to 2050 as tourism increases. Figure 5.7 highlights the extent of nutrient loading to the Baltic Sea by sub-basin in 2010. Even if nutrient inputs decrease as a result of tightened regulation, visible effects may not be discernible for decades (SEPA, 2009).

Figure 5.7. **Water- and airborne inputs of nitrogen and phosphorus to the Baltic Sea by sub-basin in 2010**



Source: HELCOM (2013), "Developments in Nutrient Inputs", Baltic Sea Trends in Eutrophication (HELCOM website).

Pollution from hazardous substances also constitutes a serious threat to the marine environment around Sweden. Contamination by persistent organic pollutants (POPs) such as PCB, DDT and dioxins, as well as heavy metals (such as mercury, lead and cadmium) has had a severe impact on biodiversity, including on populations of seals, eagles and guillemots. Hazardous substances stem from point sources, land-based diffuse sources and atmospheric deposition; examples include industry, agriculture, household consumer produce, traffic, shipping and energy production (Ministry of the Environment and SwAM, 2013).

Fisheries and aquaculture

Alongside eutrophication, overfishing is one of the main causes of ecosystem destruction in Swedish waters. Until the middle of the 20th century, fishing was carried out on a fairly small scale, but technical advances around that time paved the way for substantial increases in catches. This led to overfishing; many commercially valuable fish stocks have been overexploited, representing a threat to the entire ecosystem (Section 3.1). Recent data suggest continued overcapacity in commercial fishing, leading to low profitability and non-compliance with fishing regulations (Blenckner et al., 2013). At present, there are restrictions on eating fish from the Baltic Sea because they contain dioxins and PCBs in concentrations above permitted limits (ICES, 2011; SwAM, 2012a).

Extraction of species by commercial fisheries is expected to increase up to 2020 and to subsequently decrease due to implementation of the EU Common Fisheries Policy, which aims to align fishing effort with maximum sustainable yields (Section 5.3). Abrasion from bottom trawling, expected to increase up to 2020, will likely decrease after 2050 in line with fishing pressure. Decreases in predatory species could allow populations of grazing species to grow. If this occurs, increasing fishing pressure may also heighten pressure on eelgrass meadows (SwAM, 2012a).

Extraction of species is considered the most important factor influencing population numbers, but hazardous substances and non-indigenous species may be significant as well. Hazardous substances from the maritime sector are expected to increase up to 2020 (Ministry of the Environment and SwAM, 2013). Climate change and ocean acidification will also likely constitute an important threat to sensitive Baltic Sea stocks; this will lead to migrations of species and an increased risk of oil spill due to extreme weather.

Maritime transport

The competitiveness of the Swedish fleet has decreased over the years, influenced by factors such as tax rules, staffing regulation, shipping economic support, administrative costs, support for financing, and research and development. In 2012, 40% of domestic and international freight was transported by ships, 36% by trucks and 24% by trains. Over the long term, road transport's share of freight transport activity has increased, while shipping has decreased. Future increases in fuel prices are expected to affect shipping and, therefore, harbour and fairway activity (Ministry of the Environment and SwAM, 2013).

Increased cargo volume and vessel size may lead to a growing risk of oil discharges and spills, which have an immediate impact on seabirds and tourism. The probability of a large (300 Mt to 5 000 Mt) or exceptional (5 000 Mt to 150 000 Mt) oil spill in the Baltic Sea is estimated at once every 4 years and once every 26 years respectively (BRISK, 2011). Nevertheless, due to higher traffic levels, oil spills are expected to increase up to 2050. The risk particularly increases for tanker accidents, due to an expected heavy growth in tanker traffic in the Baltic Sea and North-East Atlantic.

There is a trend in shipping to replace fossil fuel with liquefied natural gas. This lowers the oil spill risk, although climate change and extreme weather patterns may also heighten risk (Ministry of the Environment and SwAM, 2013). In areas affected by oil spills, fishing is often prohibited due to the risk that fish will contain pollutants. Hence, effective policy for oil spills may avoid losses and save costs in the fishing industry.

Non-indigenous species

Ballast water may contain non-indigenous species of fish, shellfish, other invertebrates, jellyfish, algae and bacteria that can change the structure of the food web. Of the 89 species that were introduced in the Baltic Sea between 1900 and 2000, 61 have established themselves in the ecosystem (BalticSTERN Secretariat, 2013). Sea transport will increase substantially in the future and impacts from non-indigenous species resulting from maritime transports are expected to increase up to 2020; this will bring with it the risk of increased dispersal of harmful alien species. Even if occurrence is small, the potential damage to the future provision of important ecosystem services could be large (Ministry of the Environment and SwAM, 2013). Currently, Sweden does not regulate the handling of

ballast water relating to invasive species. However, when the IMO Ballast Water Convention enters into force, the Swedish Transport Agency will enact more specific measures on ballast water.

Climate change and ocean acidification

Since the start of the industrial age around 200 years ago, water temperature in the North Atlantic has risen by 0.1°C and the seas have become 30% more acidic (Ministry of the Environment and SwAM, 2013). Although these changes may seem small, geographical distribution patterns for some marine species and ecosystems have already changed. Climate projections for the coming decade show the world's oceans will change more quickly than before. Warming reduces the capacity of land and ocean to absorb atmospheric carbon dioxide concentrations, leading to increased acidification of the ocean. No specific figures have been estimated for the Baltic Sea, but global sea levels are expected to rise by 26-82 cm by the end of the century (Meehl et al., 2007). Higher water temperatures and decreased salinity will have a large impact on flora and fauna in Swedish waters, as well as the commercial viability of fisheries. While winter ice usually covers the northern parts of the Baltic Sea, a milder climate could reduce ice cover by 50-80% by 2100. While these conditions would increase access for shipping, they would also threaten populations of the Baltic ringed seal, an endemic species dependent on ice surfaces for reproduction (Ministry of the Environment and SwAM, 2013).

As well as directly affecting ecosystem services, climate change can affect land use, precipitation, surface water run-off and other factors that may result in further eutrophication (BalticSTERN Secretariat, 2013). Climate change could also reduce precipitation, leading to a decrease in the Baltic Sea's mean salinity and, therefore, to intensified eutrophication and algal blooms. Climate change also has an impact on coastal erosion and flood damage. As well, the rise of water temperatures increases the probability of invasive species and less marine biodiversity (Garpe, 2008). These changes may lead marine species to move to new habitats, or in the worst cases, to their extinction. In addition to dramatically altering the composition of marine ecosystems, these changes will affect the provision of marine ecosystem services, particularly for fishing, tourism and other trades (Meehl et al., 2007).

Freshwater shortage

The quality of most rivers discharging into the Baltic Sea is fair (moderate organic pollution and nutrient content) or poor (heavy organic pollution, low oxygen concentration, sediment locally anaerobic). However, the overexploitation of groundwater in densely populated coastal areas has caused saltwater intrusion in aquifers, which may affect drinking water quality. Given implementation of the Water Framework Directive by countries surrounding the Baltic Sea (except Russia), an improvement in the quality of freshwater is expected in the future (UNEP et al., 2005).

Marine litter

Marine litter is considered to be one of the major threats to oceans worldwide. Marine littering along the Swedish west coast is of concern and has been monitored since 2001. The few existing studies of marine litter in the Baltic Sea show that each cubic metre of water can contain hundreds of thousands of pieces of microscopic plastic particles. In the

sea, marine litter can entangle fauna such as seals, fish and seabirds. Since litter often resembles food, it can also cause physical injuries and famine, contributing to transfer and movement of invasive species. On the coastline, marine litter poses potential harm to flora and fauna, as well as causing damage to industry and reducing the aesthetic quality of the coastal environment (SwAM, 2013). Despite numerous regulations targeting the three major drivers of marine litter (shipping, fishing and recreation), the effectiveness of marine litter policies is limited.

4. Institutional and policy frameworks for the conservation and sustainable use of marine ecosystems

4.1. Institutional framework

Globally, over the last decade, there has been increasing focus on the ecological status of the marine environment and the need to tackle environmental problems present in marine ecosystems. Concurrently, human activities at sea and throughout catchment areas are increasing pressure on marine and water ecosystems. This has led to calls for a more coherent marine and water institutional and policy framework internationally, in the Baltic region and also within Sweden. SwAM was formed in 2011 to integrate fisheries, marine and water management issues more effectively. It is considered a first step towards a more holistic and ecosystem-based approach to the entire marine and water environment in Sweden.

Sweden has a three-tier system with national, regional and local levels of government (Chapter 2). Responsibility for marine policy at the national level is divided among the Ministry of the Environment (environment); the Department of Rural Affairs (fisheries) and the Department of Transport (shipping). However, all ministries have responsibilities for environmental impacts in their field. Supervision of measures affecting the marine environment is divided among several agencies. There is no national registry for enforcement action, and the Environmental Code does not separate between reporting of marine and freshwater enforcement actions.

Since the ministries are comparatively small, government agencies such as SwAM implement policies and programmes at national level, and the county administrative boards (CABs) at the regional level (Chapter 2). SwAM has taken steps to clarify what information CABs should report regarding the supervision of water activities and the Fisheries Act.

4.2. National environmental quality objectives

The Swedish system of environmental quality objectives (EQOs) aims to give an overall view of national environmental policy, including marine ecosystems (Chapter 2). Five of the 16 EQOs to be achieved by 2020 relate to marine ecosystem services: A balanced marine environment; Flourishing coastal areas and archipelagos; A non-toxic environment; Zero eutrophication; A rich diversity of plant and animal life; and Flourishing lakes and streams (Box 2.2). The EQOs also include overarching environmental aims, such as a sustainable fishery, as well as good ecological, environmental and chemical status within the EU and international commitments.

The 1999 Environmental Code (Chapter 2) regulates a number of sectors with activities or actions affecting marine areas, including discharge, landfills, dredging, excavation,

dumping and water drainage (Ministry of the Environment and SwAM, 2013). Key legislation in marine and water management in Sweden is established at the EU level. Compliance with EU directives is necessary to ensure good environmental status of the marine environment. Decisions and initiatives are required at the EU level to achieve a number of environmental objectives, including some national ones. For the marine environment, the European Union has decided on an integrated maritime policy (IMP). A corresponding action plan gathers all maritime activities into a single framework to co-ordinate the development of sea-based activities in an ecosystem-focused approach. In 2009, Sweden adopted the Bill "A coherent Swedish maritime policy". It embraces a holistic approach to the use and management of the sea and coastal areas to ensure that ecosystems are maintained and restored while economic activities linked to the sea can develop (Ministry of the Environment, 2009).

As a member of regional seas conventions, Sweden must also meet a number of objectives that contribute to the maintenance and recovery of ecosystem services. Although Sweden is a member of numerous regional frameworks, it focuses regional environmental commitments within the Helsinki Commission (HELCOM) and the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention).

Sweden's large number of ambitious national and regional ecological quality objectives in the marine and water fields often employ complicated and extensive administrative processes. This has sometimes led to calls for strengthened implementation of existing legislation, better co-ordination and streamlining of procedures and management systems, and improved priority setting. This could contribute to more effective management and use of resources, as well as increased understanding and engagement from organisations, citizens and politicians. This, in turn, could strengthen outcomes for achieving stated objectives.

4.3. Monitoring progress towards environmental objectives for sea and freshwater

EU directives, regional seas conventions and the Swedish EQO system call for the identification and development of indicators of good environmental status of Sweden's marine environment. Assessments are conducted within the EQO framework and as part of the national implementation of EU directives (MSFD, WFD, the habitats and birds directives) and regional seas conventions (HELCOM, OSPAR). SEPA co-ordinates environmental monitoring in Sweden at the national, regional and municipal levels. SwAM is responsible for the environmental monitoring of marine and inland waters, except for the monitoring of hazardous substance, which is under SEPA's responsibility. However, a lack of data is still problematic for assessing environmental status.

Red Lists present analyses of the extinction risk of individual species. The 2010 Red List of Swedish Species is the third such list based on the post-1993 IUCN Red List Categories and Criteria. The Red List serves as an important indicator of the fulfilment of both national environmental objectives and international agreements, especially the 2010 biodiversity target. While there is no automatic link between the species on the Red List and national protection or EU legislation, the majority of species nationally protected by Swedish and European law are also red-listed. The appendices of the habitats and birds directives include 170 of the red-listed Swedish species; similarly, a number of red-listed species are included in international conventions ratified by Sweden, including the

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Bern Convention and the Convention on Migratory Species.

5. Integrating the ecosystem approach into Sweden's marine policy

5.1. *The ecosystem approach*

The ecosystem approach to the management of marine waters considers human activities as part of a single system where all sectors are integrated, allowing the wider consequences of decisions to be determined and managed.[11] In contrast, traditional management approaches have tended to be sectoral, considering individual ecosystem components in isolation. This has often led to poor decisions, conflict over space and resources, environmental degradation and economic losses.

Quantifying the ways in which ecosystem services provide benefits to human populations, and expressing these values in monetary units that can be compared with other sources of value to society, can help improve decision making (Box 5.1). Economic valuation allows the measurement of benefits and costs, enables policy makers to identify and evaluate trade-offs and, if appropriate, to consider trade-offs in environmental policy design. It can help justify and set priorities for programmes, policies and actions that protect or restore ecosystems and their services. Without economic evaluation, ecosystem services may be systematically undervalued in decision making because their full value cannot be quantified in a market or is simply not known (DEFRA, 2007).

A recent inquiry suggested methods and measures to better evaluate ecosystem services and to improve the knowledge base of the societal value of ecosystem services. It also proposed ways to mainstream the importance of biodiversity and the value of ecosystem services; in so doing, these could become better integrated into economic positions and other decisions in society, where relevant and reasonable (Ministry of the Environment, 2013).

An ecosystem approach does not favour a certain type of policy instrument. Instead, the optimal choice of instrument depends on criteria considered important for each specific case. In particular, the policy instrument must balance among cost effectiveness, management effectiveness, legitimacy and purely practical considerations. The following sections show that Sweden has implemented the ecosystem approach in a number of ways, often in the context of EU and regional co-operation commitments.

However, it is difficult to draw strong conclusions about the actual incorporation of the ecosystem approach in the national context in Sweden. Most ecosystem service evaluation studies have targeted limited areas. Scientific uncertainty, ecological complexity, political apathy and data brevity are barriers to the increased use of economic valuation of nature in Sweden's policy development. The successful implementation of the ecosystem approach will ultimately require the integration of regulatory and technical information, and extensive collaboration among European Union member countries, between agencies and across disciplines. It will also require major efforts to adapt current systems of environmental assessment and management. Finally, it should consider a much broader set of impacts on ecosystem status than is currently addressed in most risk assessments. Overcoming these obstacles, however, is worth it: a clearer focus on ecosystem services in policy development and implementation will contribute to meeting the challenges of the future.

5.2. *Marine strategy framework directive (MSFD)*

The Marine Strategy Framework Directive (MSFD), adopted in June 2008, is the environmental pillar of the IMP. To promote sustainable use of the seas and to conserve marine ecosystems, the MSFD puts in place measures that will lead to, or maintain, good environmental status (GES) of the EU's marine waters by 2020. The directive is the EU's first concerted attempt to apply an ecosystem approach to regulate and manage the marine environment.

The MSFD requires member states to develop a region- or sub-region-based strategy for their marine waters. In co-operation with other countries that share the same region or sub-region, strategies must use an approach that covers whole ecosystems; regional seas conventions support this co-ordination. A strategy must include an initial environmental assessment of GES and set related targets (already undertaken by Sweden). It should be followed by the development and implementation of a monitoring programme (by 2014), and the development (by 2015) and implementation (by 2016) of a cost-effective programme of measures. A marine strategy should be reviewed and updated every six years. An impact assessment with a detailed cost-benefit analysis is required before any new measure is considered.

The MSFD, implemented by SwAM, could incorporate marine ecosystem services into national policy making. Initial assessment involves co-operation on multiple levels to harmonise policy with local, regional (sub-national), national and international legislation. The process also highlights knowledge gaps regarding relationships between impact and the state of the environment. These knowledge gaps point to the need for future research and knowledge acquisition. In 2012, Sweden submitted the initial assessment, a report and a regulation regarding GES, environmental targets and indicators to the European Commission, in line with the timetable.

The MSFD features a science-driven methodology with clear deadlines. It is adaptive and focused on enhancing co-operation and co-ordination among member states. Provisions on updating, reporting and public information also ensure a high degree of both transparency in implementation and stakeholder participation in decision making. However, generic terminology such as "good environmental status" means that success depends on how well member states transpose MSFD provisions into national law. Future success will also likely depend on improved regional co-operation and data sharing. Nevertheless, the protection of the marine environment, sustainable management of marine natural resources and the conservation of functioning ecosystems are binding legal obligations.

5.3. *The common fisheries policy (CFP)*

The Common Fisheries Policy (CFP) is the most important policy tool for fisheries in Sweden's seas. Within the EU framework, member states implement the CFP based on the principles of common management and equal access for all EU fishers. Reforms in 2002 shifted emphasis from a narrow preoccupation with fish stock management towards a more holistic and ecosystem-based approach. Its basic objectives include the application of the "precautionary principle" and the progressive implementation of an ecosystem approach. Ongoing CFP reforms aim to strengthen this approach to ensure long-term environmental and economic sustainability. CFP regulations apply directly to member states and do not need to be incorporated into domestic regulation.

Sweden has attempted to initiate reforms nationally in advance of developments at the EU level. For example, with respect to a new regional fisheries management agreement between Norway, Denmark and Sweden in the Skagerrak, the parties agreed on rules requiring gear to reduce bycatch, as well as a discard ban in the agreement area.[12] In some cases, Sweden has gone further than CFP regulations. For example, it banned Swedish fishers from catching salmon with driftlines in the Baltic Sea and required the use of selective grids in shrimp and nephrops trawling in the Skagerrak. This led to reduced bycatches of cod and other species and subsequently improved the environmental impact on stocks within this fishery.

The main piece of Swedish national fisheries legislation is the Fisheries Act (fiskelagen), which broadly covers the right to fish for both recreational and professional fishers. The act entered into force in 1994, before Sweden became a member of the EU, and has been amended several times. In 2007, the government acknowledged the need to revise the act to better align it to the EU CFP and better address short-term overexploitation of fishing resources. The government proposed, among other things, to incorporate an environmental impact assessment into the permit system for commercial fishers. At the time of writing, the reform of the Fisheries Act was still under parliamentary discussion.

Swedish fisheries are exempted from fuel tax. As the fishery is not part of the EU emission trading system for CO_2, exemptions from fuel taxes mean that fishers have little or no incentive to reduce fuel consumption. This counters the aim of supporting small-scale fisheries since large-scale trawl fisheries obtain a competitive advantage due to higher rates of fuel consumption. The possibility of bunkering fuel in neighbouring countries makes a decrease of these subsidies difficult, due to a lack of co-ordinated international action.

5.4. *Water framework directive (WFD)*

The Water Framework Directive (WFD) provides general normative quality standards for the management and use of freshwater and coastal water ecosystems in the EU, as well as for those terrestrial ecosystems directly dependent on the aquatic environment. Previous EU water-related directives were specific with respect to pollutants and protected water use. However, in setting either ambient water quality or source-specific emission standards, the WFD defines objectives for the protection and sustainable use of all water ecosystems in a holistic manner (Hartje and Klaphake, 2006).

The overarching goal of the WFD is to achieve adequate ecological and chemical status of water by 2015, with possible extension to 2027. It sets a timetable to achieve the goals and provides a framework for their implementation. Member countries should develop river basin management plans (RBMPs) indicating the programmes of measures to achieve good environmental status of water bodies. Sweden is generally on track with the WFD timetable; it reported to the European Commission in 2009 and 2012. The European Commission considered that Sweden needed to better target measures to pressures and better clarify the scope, funding and timing of measures. In addition, Sweden does not monitor all relevant biological quality elements and little biological monitoring appears to take place in water bodies (European Commission, 2012).

Five regional water administrations in Sweden establish, assess, classify and monitor water bodies, as well as issue environmental quality standards within their administrative

regions. SwAM co-ordinates, and provides guidance to, the regional water administration, and reports to the European Commission.

5.5. *Implementation of the Helsinki and OSPAR conventions*

Helsinki convention and HELCOM

The Helsinki Convention's primary objective is to restore the ecological quality of the Baltic Sea region by 2021. To that end, it proposes national action and intergovernmental co-operation in the key areas of eutrophication, hazardous substances, biodiversity and maritime activities. The convention covers the entire Baltic Sea area, including inland waters, the waters of the sea itself and the seabed. HELCOM, which is responsible for implementing the convention, co-ordinates a joint monitoring programme of the Baltic Sea and operates as a regional co-ordinating platform for implementing the MSFD (Section 5.2).

HELCOM has drawn up and adopted more than 150 recommendations to protect the sea. However, the convention has no binding agreements, including with respect to necessary nutrient load reductions. In the 1980s, governments around the Baltic Sea agreed to halve total emissions of both nitrogen and phosphorus, but never met this target. The HELCOM Baltic Sea Action Plan (BSAP), adopted by the Baltic Sea countries and the EU in 2007, aims to achieve good environmental status in the Baltic Sea by 2021. The plan has four intermediate objectives for the Baltic Sea: a sea unaffected by eutrophication, marine life unaffected by hazardous substances, a favourable conservation status for biodiversity and environmentally friendly shipping. It defined a new set of provisional load reduction targets as part of an ecosystem approach. The task of developing cost-effective policy instruments to attain the targets and co-ordinate policies across sectors, regions and measures is still underway (Elofsson, 2010).

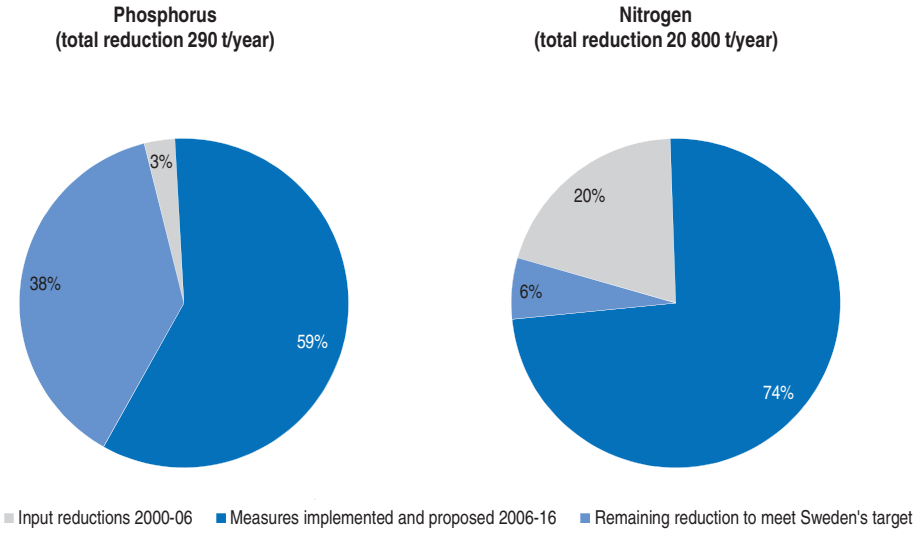
Analysis of BSAP commitments and results in Sweden has shown a delay in national implementation, inadequate reporting systems and insufficient mechanisms for co-ordination. Despite progress and implemented measures, Sweden needs to further reduce inputs of nutrients to the Baltic to meet its national reduction target under the BSAP (Figure 5.8). Revised targets were adopted at the HELCOM Ministerial Meeting in October 2013. Successful implementation of the BSAP depends on Baltic Sea countries realising their need for, and benefits of, co-operation across borders, sectors and levels of government (WWF, 2013).

Combining ecological and economic models, BalticSTERN (Systems Tools and Ecological-economic-evaluation – a Research Network) works with partners in all Baltic Sea countries to make cost-benefit analyses and identify cost-effective measures of improving the environmental state of the Baltic Sea. Initially supported by SEPA (September 2009-June 2011), SwAM funded the network in 2011-13. Recent reports have estimated the costs of a range of measures to reduce nutrient loads, including from inland-based sources such as the agricultural sector and wastewater treatment plants. BalticSTERN estimates the costs of reaching marine environmental targets at EUR 2.3-2.8 billion annually, depending on the allocation of measures (SwAM, 2013).

OSPAR convention

OSPAR is comprised of 15 countries and representatives of the EU charged with the work of the OSPAR Convention, whose goal is to protect the marine environment of the North-East Atlantic. For this purpose, the North-East Atlantic environmental strategy is

Figure 5.8. **Sweden's progress towards 2016 reduction targets for phosphorus and nitrogen inputs to the Baltic Sea as of 2010**



Source: SEPA (2010), "All graphs in the report de Facto 2010"; Environmental Quality Objectives Portal.

divided into five areas: biological diversity and ecosystems; eutrophication; hazardous substances; offshore oil and gas industry; and radioactive substances (OSPAR, 2013). OSPAR also hosts a Strategy for Joint Assessment and Monitoring Programme, which assesses the status of the marine environment, implementation of strategies and resulting changes.

A meeting of the contracting parties in 2013 developed a first set of common indicators to assess the status of the North-East Atlantic and its sub-regions. This is a step forward in co-ordinating and extending marine monitoring within the OSPAR area, as required by the MSFD. OSPAR is also tackling the issue of marine litter by developing a regional action plan by 2014, and has established MPAs within its framework. In 2003, environment ministers under HELCOM and OSPAR adopted a declaration to work together and with the EU.

SwAM has structured Swedish work towards OSPAR and developed an action plan for the period 2013-16. The plan addresses the issue of vertical co-ordination and co-operation. National agencies, the county administrative boards (CABs) and the scientific community have all been invited to implement the action plan. The plan puts biological diversity and MSFD co-ordination at the centre of future work and suggests regular *ex ante* evaluations of OSPAR agreements and implementation follow-up. It proposes the following thematic areas as priorities: marine biodiversity (including ecologic coherence analysis), eutrophication, marine litter, cumulative effects and human health, ocean acidification, spatial allocation and distribution of marine activities, baselines for concentration of radioactive substances and sustainability perspectives for emerging offshore industries. With shrinking budgets, the cost of implementation remains a challenge.

5.6. Marine spatial planning

The increasing use of seas and coasts for economic activities leads to growing and competing demands for maritime space. Clear allocation of space at sea helps avoid conflicts between different users and integrate human activities into an ecosystem approach for the coastal and marine environment. Marine spatial planning (MSP) is a

relatively new approach to overall planning of the use of seas and coastal areas.[13] In March 2013, the European Commission proposed a directive that would oblige member states to use an ecosystem approach for marine spatial plans and integrated coastal management strategies and to co-ordinate these plans and strategies with other member states. Member states would be responsible for planning and content, but each would have to ensure public participation, establish cross-border co-operation and organise the collection and exchange of data and information. The directive is expected to be agreed by the European Council and Parliament in 2014.

MSP directs the use of marine waters and identification of areas best suited for competing activities such as environmental protection or certain types of development. In the Baltic Sea, many marine issues such as shipping, fisheries, wind power developments and environmental protection have strong transboundary dimensions. Planning, where the public sector provides a framework for the future use of large sea areas, is crucial for sustainable development of the sea. MSP principles based on the ecosystem approach have already been adopted and tested as part of the implementation of the HELCOM BSAP (2007). The first pilot project on transboundary MSP also took place in the Baltic Sea (Box 5.3).

Box 5.3. **Planning the Bothnian Sea**

The Bothnian Sea is a clearly delineated sub-basin of the Baltic Sea shared by Sweden and Finland. While the two countries have similar administrative structures, practices and views on planning, neither country has planned its exclusive economic zone (EEZ). These factors enabled a pilot transboundary marine plan for the Bothnian Sea to be established. The initiative, co-ordinated by the HELCOM Secretariat, ran between December 2010 and May 2012. Under the plan, the social dimension of MSP plays a role in safeguarding the public good and civic well-being, the economic dimension contributes to boosting growth and prosperity, and the environmental dimension is strengthened by the ecosystem approach, which is often mentioned as a key characteristic of MSP. Using this approach, the area's ecosystem provided both the basis and boundaries for planning. In addition, the plan recognises that information on a number of maritime issues is often scarce; maritime planning thus requires extensive preparation to gather and process accurate information on offshore areas. As this was a pilot project, the draft plan was not actually implemented. In October 2013, the Swedish government led a public consultation on new legislation to implement MSP in the territorial waters and EEZ. The government is currently evaluating the consultation in order to prepare a formal legal bill for the Swedish parliament.

Source: Backer, H. et al. (2012), *Planning the Bothnian Sea: Outcome of Plan Bothnia – A Transboundary Maritime Spatial Planning Pilot in the Bothnian Sea.*

The Planning and Building Act of 2011 regulates spatial planning of municipalities, which also includes the territorial sea until the border with the exclusive economic zone (EEZ).[14] However, MSP is the responsibility of the central authority, while municipalities are in charge of coastal zone management. In practice, MSP has not been as important as territorial planning in Sweden. Although every municipality must have an updated comprehensive plan covering its entire area, only a few of the 85 coastal municipalities have included the marine area in their comprehensive plans (Ministry of the Environment and SwAM, 2013). There is, therefore, a lack of spatial planning for marine waters and

coastal areas. In any case, spatial plans are only guides, and the Environmental Code is often not taken sufficiently into account in the planning. A commission on MSP proposed a new system of national planning of sea areas and an MSP Act to cover all Swedish waters seawards from a line of one nautical mile outside the baseline, including the EEZ. An ecosystem approach is fundamental to the proposed system, meaning that the structure and functioning of ecosystems and their ability to provide societies with goods and services must be maintained or restored where necessary. Work continues on a government bill.

5.7. Integrated coastal zone management (ICMZ)

Developments and activities in marine waters often have implications onshore ranging from changing infrastructure requirements to negative or positive economic impacts on communities. These connections can be effectively addressed through integrated coastal zone management (ICZM). Sweden has no formal process to develop and implement ICZM and has taken no steps to establish it, although the WFD does introduce such elements. In line with the OECD recommendation to implement an ICZM programme and strengthen the capacity of local planning authorities to protect coastal zones, the Planning and Building Act and the Environmental Code make provisions for shore protection. Shore protection comprises all land and water areas (inland and offshore) from 100-300 metres from the shoreline. All development is prohibited within this area, including the construction of new buildings, fences or piers (although exemptions may be granted). The Swedish approach to coastal management and planning has been very successful from an environmental conservation standpoint (European Commission, 2013). This may be why Sweden does not consider ICZM a priority, at least not from an environmental point of view.

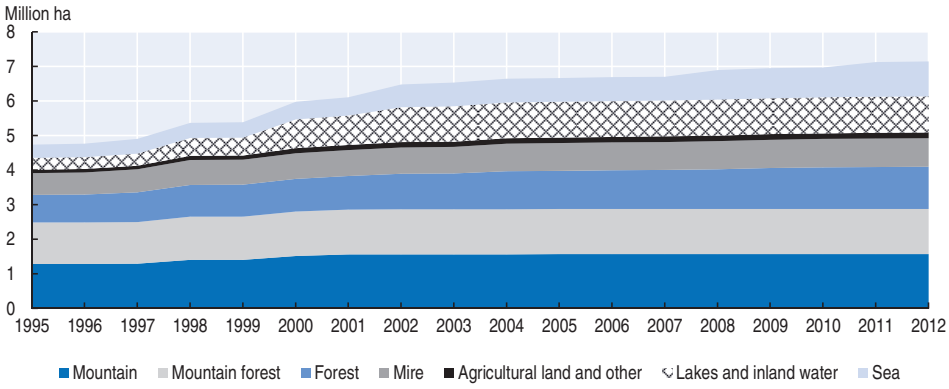
Integrated coastal zone management is also under the remit of the Helsinki Commission Nature Conservation and Coastal Zone Management Group, commonly referred to as HELCOM HABITAT. This body promotes coastal zone management plans as instruments for environmentally sustainable development in coastal and marine areas. To reach these goals, HELCOM HABITAT will review and observe the status of biodiversity conservation in the Baltic Sea countries, identify gaps and deficits, and develop strategies.

5.8. Marine protected areas, nature reserves and national parks

MSP can also incorporate marine protected areas (MPAs), nature reserves and national parks, each offering a different level of legal protection. MPAs and marine Natura 2000 sites have increased since the mid-1990s (Figure 5.9). As part of the government's comprehensive action plan for the marine environment, as recommended by the OECD, Sweden created 19 MPAs and 6 no-fishing zones. Overall, Sweden is far from reaching the Aichi target of establishing a system of protected areas covering at least 10% of coastal and marine areas by 2020. Marine protected areas cover 6.3% of Sweden's sea area, with about 30% of the Skagerrak being protected. About 5% of Sweden's national territorial waters and exclusive economic zone in the Baltic Sea is currently protected within the HELCOM Baltic Sea Protected Areas (HELCOM, 2013b) (see below). In general, more coastal areas are protected than offshore areas.

In Sweden, after consulting with landowners and other concerned parties, both the CAB and the affected municipality can establish nature reserves to preserve biodiversity, maintain and preserve valuable natural habitats, or meet needs for outdoor recreation. The land may be publicly or privately owned. As part of establishing a nature reserve, the CAB or municipality must create management plans for the long-term management of the protected area.

Figure 5.9. **Extension of protected natural areas and Natura 2000 sites in 1995-2012**



Source: Statistics Sweden (2012), *Protected nature 2012*.

StatLink http://dx.doi.org/10.1787/888933145336

The Environmental Code enables the government to declare state land or water as a national park. National parks preserve a large contiguous area of a particular type of landscape or several types of landscapes in their natural state. Sweden's first marine national park, Kosterhavet, was established in 2009 (Box 5.4). Sweden has limited information on the cost of MPAs with the exception of the Kosterhavet National Park, where there is a yearly maintenance budget of SEK 5 million.

Box 5.4. **Kosterhavet national park**

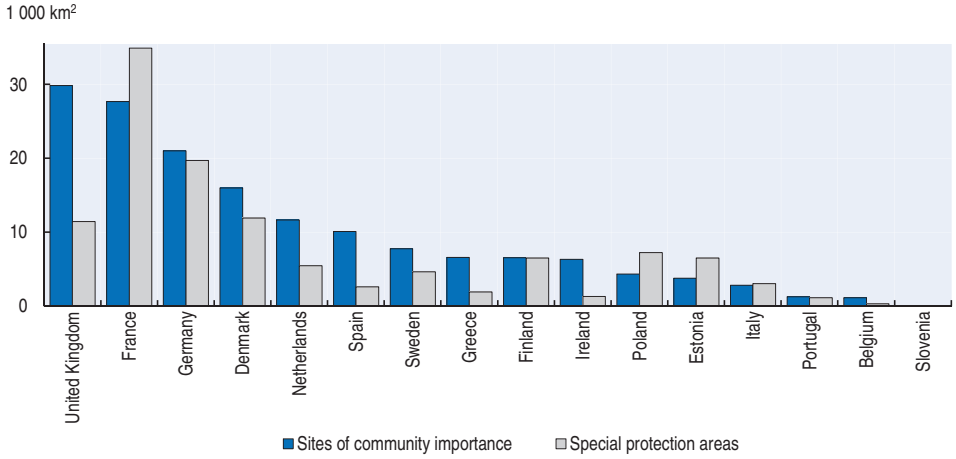
The idea of protecting Kosterhavet as a national park goes back to the late 1980s, as the area has habitats and species found nowhere else in Swedish waters. However, fishers of prawns and Norwegian lobsters, in particular, were against it, fearing they would lose their means of subsistence. After same failed attempts, discussion for the establishment of the park resumed in 2000, when the area was designated as a Natura 2000 site. Negotiations with local populations and fishers focused on the rationale for protection, using maps of the sea floor, which displayed the conditions and requirements for species to flourish. The educative nature of the process has led to a successful outcome and Kosterhavet National Park was inaugurated in September 2009. In a new model of co-management, representatives from the involved municipalities, fishers and local community organisations maintain the park according to guidelines. Commercial fishing is still allowed although special regulations apply.

Source: SEPA (2013), Kosterhavet National Park website, Swedish Environmental Protection Agency.

Sweden has also committed to protecting marine areas identified by HELCOM (Baltic Sea Protected Areas – BSPAs) and the OSPAR Convention, known as MPAs of the North-East Atlantic. Between 2004 and 2013, BSPAs have expanded from 3.9% to 11.7% of the total marine area of the Baltic Sea, with Sweden's BSPAs representing about 15% of the total protected Baltic marine area (HELCOM, 2013b). The BSPAs themselves have no legal protection, although they partly overlap with other categories of protected areas and Natura 2000 sites. Some 17.5% of Sweden's marine waters under the OSPAR Convention is protected via 10 MPAs of the North-East Atlantic.

The habitats and birds directives play an increasingly important role in the integrated approach to management of marine resources, including the establishment of the Natura 2000 network. In total, 59 species are threatened or declining in various Baltic Sea areas (HELCOM, 2009). In the Baltic Sea, the habitats and birds directives apply to marine internal waters, the territorial sea and the EEZ of member states. However, relatively few Natura 2000 sites have been identified in offshore waters: the largest single gap in the network. Marine habitats account for about 8.5% of habitats covered by Natura 2000 sites in Sweden (SEPA, 2010). Compared to other EU countries and given Sweden's long coastline, the size of these sites is relatively small (Figure 5.10). Natura 2000 sites do not entirely overlap with other protected areas such as nature reserves and national parks. There is a lack of coherence in the EEZ since the CABs lack a mandate to establish nature reserves. In these areas, protected areas are often OSPAR marine protected areas or based on the HELCOM BSPAs (see above). Conservation and management plans for MPAs exist for most, but not all, such areas. The Habitats Directive requires an environmental assessment of projects in Natura 2000 sites. Incorporating an ecosystem services approach into assessments could contribute to a more holistic evaluation.

Figure 5.10. **Marine Natura 2000 sites in EU member countries of the OECD in 2011**



Source: European Commission (2013), *Natura 2000 Barometer, February 2011.*

StatLink http://dx.doi.org/10.1787/888933145347

The need to protect species and habitats from the impacts of fishing activities can be seen as a component of the ecosystem approach. Although fishing is not the only human activity that can damage vulnerable marine habitats and species, it is very important. The Common Fisheries Policy therefore plays a major role in ensuring the success of the Habitats Directive (Section 5.3).

5.9. Economic incentives and subsidies

Sweden has a long tradition of making use of economic instruments in environmental policy (Chapter 3). A number of economic instruments are applied to reduce water pollution, thereby contributing to improved quality of the marine environment. Wastewater pollution charges, calculated as a function of effluent loads, are imposed on industrial water users connected to public wastewater treatment plants. No charge applies,

however, to agricultural water use. A tax on pesticides has been in place for 30 years to help reduce the use of pesticides and the associated health and environmental risks. Two economic instruments aim to combat eutrophication: the tax on mineral fertilisers containing nitrogen (to reduce leaching of nitrogen to groundwater) and the charge on emissions of nitrogen oxides (NO_x) from large combustion plants (to reduce nitrogen atmospheric deposition). The NO_x tax has been cost effective in accelerating emission reduction (OECD, 2013), and the tax on nitrogen fertilisers, which is no longer in force, helped reduce leaching by an estimated 1 300 to 1 800 tonnes of nitrogen per year (Lindhjem et al., 2009). The 2009 Bill "A coherent Swedish maritime policy" foresees the implementation of a trading scheme for discharges of phosphorus and nitrogen marine pollution, with the aim of reducing eutrophication of the Baltic and North seas in a cost-effective manner. In 2012, SEPA elaborated such a proposal, which has not yet been implemented.

Sweden also introduced economic incentives to reduce sea pollution from ships. A pollution charge applies to oil spills; it is based on the discharged amount and the size of the vessel, and is intended to work as a deterrent. Since 2004, shipping lane duties have been differentiated on the basis of bunker fuel sulphur content and of NO_x emissions from ships. The Swedish Maritime Administration estimates these differentiated shipping lane duties have helped accelerate the introduction of nitrogen removal equipment on board ship (Lindhjem et al., 2009).

Sweden has limited experience with the use of payment for ecosystem services (PES) in marine areas or for improving the quality of the marine environment. PES is a mechanism that uses economic incentives to improve environmental management. As an underlying principle of PES, those who benefit from a service should be willing to pay for it.[15] An example of PES is Sweden is the contracts for aquaculture facilities (mussel farming on the Swedish west coast) that aim to mitigate eutrophication from the discharge of urban wastewater treatment plants (Box 5.5). Regional subsidies also exist for establishing riparian buffer zones to minimise leakage of nutrients from arable land.

PES relies on long-term property rights, which are usually more clearly established for land-based ecosystems than for marine ecosystems (Zandersen et al., 2009). This has limited the use of PES programmes in marine areas. Marine and coastal spatial planning and the establishment of MPAs are methods of assigning ownership of sea areas, paving the way for implementing PES programmes. Valuation studies can then determine entry fees for users who want to use marine ecosystem services within MPAs (e.g. visitors who dive or fishers who target fisheries that use MPAs as breeding or nursery grounds). There is also significant scope for private sector engagement in biodiversity conservation with opportunities for positive financial returns and biodiversity benefits; the creation of biodiversity "banks" in marine/aquatic ecosystems, for example, could offset degradation due to development. Swedish authorities would need to create enabling conditions for such trades and ensure they are supplementary, and do not contradict or overlap with other natural resource management regulation (Zandersen et al., 2009).

Sweden has provided a number of grants to support protection and restoration projects in marine waters. The "budgetary allocation 1.12", introduced in 2007, was a grant to improve, preserve and protect the marine and aquatic environment. Government grants to local water management initiatives (LOVA grants) have also been available since 2009. They cover up to 50% of costs of measures to reduce phosphorus and nitrogen load, restore

Box 5.5. **Mussel farming to reduce eutrophication**

Farming of blue mussels can help reduce nutrient leakage from agriculture and wastewater treatment, thereby improving water quality; at the same time, mussels can be used as forage or nutrient for organic agriculture. Between 2005 and 2011, in Lysekil municipality, the local wastewater plant paid a mussel farmer to remove nutrients from the coastal waters where the wastewater treatment plant discharged. Payments were based on the content of nitrogen and phosphorous in the harvested mussels. Wastewater treatment in Lysekil discharged 39 tonnes of nitrogen per year into the bay; programme results show that 3 500 tonnes of blue mussels per year help fully remove this nitrogen load, exceeding the minimum requirement of 70% nitrogen removal. In addition, the mussels capture phosphorus and organic material that would otherwise put stress on the marine environment. This PES programme has saved the municipality about EUR 100 000 per year compared to a traditional nitrogen removal technique. Similar programmes are in place in the Trosa Archipelago and Kalmar Strait. The 2009 Bill "A coherent Swedish maritime policy" foresees the expansion of mussel farms to reduce levels of eutrophication by phosphorus and nitrogen along Sweden's coast.

Source: Zandersen, M., K. Grønvik Bråten and H. Lindhjem (2009), "Payment for and Management of Ecosystem Services, Issues and Options in the Nordic Context".

valuable and degraded habitats, and install stations for boat sewage disposal and for removing hazardous antifouling paints from boat hulls (Ministry of the Environment, 2009). With the establishment of SwAM, the budgetary allocation 1.12 expanded to include the LOVA grants, and support to water management, liming and fish conservation management (Table 5.4).

Table 5.4. **Budgetary allocation to enhance, preserve and protect the marine and aquatic environment**

SEK 1 000

	2007	2008	2009	2010	2011	2012	2013
Budgetary allocation 1.12	38 500	100 000	284 800	369 800	578 749	737 565	502 565
LOVA†			45 627	100 395	*	*	*
Liming projects	188 000	188 000	188 000	188 000	*	*	*
Fisheries management	26 800	26 800	27 837	24 532	*	*	*
Total	253 300	314 600	546 264	582 332	578 749	737 565	502 565

Notes: *Since 2011, these grants have been included in the budgetary allocation 1.12.
†LOVA are government grants for local water initiatives aimed at reducing eutrophication.
Source: Country submisssion.

Swedish government financial transfers (GFT) for the protection and sustainable use of marine fish stocks are estimated at approximately SEK 500 million per year from 2009-11 (Table 5.5). Grants from the European funds for fisheries are administered by the Swedish Board of Agriculture and the CABs.

The Environmental Code (Chapter 2) regulates the impact of agriculture on water habitats**.** The Swedish rural development programme, approved in the framework of the Common Agriculture Policy (CAP), comprises subsidy measures for reduced nutrient leaching. During 2007-13, about SEK 510 million was allocated for this purpose (roughly the same as for 2001-06). There was a slight increase from the years 2003-05. The Swedish Agricultural Board and the CABs administer the European Agricultural Fund for Rural

Table 5.5. **GFTs for the protection and sustainable use of marine fish stocks**
SEK million 2009-11

	2009	2010	2011
Marine capture fisheries (Total)	469	524	502
Decommissioning of vessels and licences	15	44	1
Grants for vessel construction, modernisation and equipment	3	-	1
Other direct payments	1	2	1
Management services	96	93	98
Research services	166	170	171
Enforcement services	187	204	223
Provision of infrastructure	1	9	4
Total aquaculture	5	4	7
Grants for aquaculture development	5	4	7
Total marketing and processing	6	11	7
Grants for marketing and processing facilities	5	7	5
General services	1	3	2
Protection and development of the aquatic flora and fauna (European fisheries fund)	8	7	7

Source: OECD (2012), *OECD Review of Fisheries 2011: Policies and Summary Statistics.*

Development in Sweden. SwAM manages the funds for marine and aquatic environments (i.e. the budgetary allocation 1.12). Out of these funds, SEK 310 million was allocated in 2013 to CABs to work with water management, liming, fish conservation, action plans for threatened species and local water projects. Measures to reduce nutrient losses to surrounding water bodies have yielded good results: a study of 65 streams in southern and central Sweden show a downward trend in concentration of nitrogen and phosphorous, directly related to implemented measures (Ministry of the Environment and SwAM, 2013).

6. Blue innovation

The "blue economy" is of key importance to Europe's overall economic health. It covers major maritime activities such as deep-sea and coastal shipping, fisheries, offshore oil and gas production, and marine and coastal tourism. It also encompasses developing or emerging sectors, such as offshore generation of renewable energy and marine biotechnology.

The blue growth strategy proposed by the European Commission in September 2012 suggests the potential of the EU's seas, oceans and coasts can be harnessed to create new job opportunities and promote innovation and sustainable growth in the blue economy. Success in this regard can contribute towards achieving the policy goals set out in the Europe 2020 strategy for smart, inclusive and sustainable growth; indeed, blue growth may be seen as the maritime pillar of this strategy. The strategy focuses on five drivers of blue growth (Box 5.6).

In 2012, Sweden launched an innovation strategy, which includes marine and water policy among its challenges for 2020. The strategy also discusses additional funding for innovation and prioritises the green economy. Although demand for technologies with minimal environmental impact is increasing both in Sweden and globally, the strategy lacks specific references to marine ecosystem services. The private sector has developed its own programmes with respect to the maritime environment known as "blue innovation" (Box 5.7).

Box 5.6. **Drivers of blue growth**

- **Blue energy.** Marine production of renewable (wind, wave, tidal or other sources) energy is regarded as a sector with strong growth potential. Apart from wind power, wave, tidal and thermal power are still at relatively early stages of development and require targeted and integrated support measures. Key elements include promotion and funding of R&D and facilitating infrastructure development and grid interconnection for delivery of energy from these sources.
- **Aquaculture.** While well established, the aquaculture sector in Europe remains relatively small and fragmented with around 80 000 employees. Heavy consumption of imported fish, depreciation of fish stocks and increased global demand for farmed fish due to rising populations could drive future growth.
- **Marine and coastal tourism.** Europe, notably the Mediterranean, is the world's leading holiday destination. The sector is hugely diverse and growth-generating initiatives will inevitably be best undertaken on a local or regional scale. Further development of port infrastructure and transport connectivity to tourist services is important.
- **Marine mineral resources.** Offshore production of oil and gas contributes significantly to the EU's blue economy. Large stocks of other minerals such as iron ore, tin, diamonds, gold, manganese, copper and zinc can also be found beneath the floors of Europe's oceans and seas. Improvements in underwater technology have made it more feasible to contemplate development of mining of minerals on the seafloor.
- **Blue biotechnology.** Research and development on marine life with a view to development of commercial or industrial applications has significant growth potential across the pharmaceutical, chemicals and cosmetics industries. Future development will require strong links between industry and research, access to financing for development and the establishment of a stable regulatory framework for the sector.

Source: Sheil, S. (2013), *Blue growth. Sustainable development of EU marine and coastal sectors.*

Box 5.7. **Examples of blue innovation**

i-tech produces environmentally adapted antifouling substances for marine paint. Biofouling (such as by algae and barnacles) can significantly degrade hull hydrodynamics and increase fuel consumption by up to 80%, as well as acting as a vehicle for the transport of invasive species. Selektope® is a non-metal degradable biocide that deters hard biofouling on vessel hulls; it provides a substitute for the toxic antifouling paints that are currently in use.

SimrisAlg farms microalgae in Sweden as a fish oil replacement for the food, feed and health markets (health supplements and food ingredients). Simris Omega-3, DHA and EPA from algae are sustainable, plant-based, not genetically modified and use clean technologies. The algae is grown in greenhouses and claims to aid cardiovascular health, immune health, metabolism, brain function and vision, healthy fetal development and cognitive development.

waves4power provides electricity from the world's biggest untapped green power resource: ocean waves. Sweden does not currently have test sites for wave energy or a national energy plan that includes waves. A pilot park is currently under construction in the UK that will harness the more constant power generated by waves, compared to wind. **Tech Market Sweden AB** retrieves nutrients, particularly phosphorous, from lake- and seabeds. Lifted sediment is separated into nutrients for recycling and waste.

Financing of blue innovation is possible through SwAM's budget appropriation. Other agencies with which SwAM co-operates, such as Vinnova and Tillväxtverket, can also finance blue innovation (Chapter 3).

Notes

1. The Baltic Sea includes the waters of the Bothnian Bay, the Bothnian Sea, the Gulf of Finland, the Gulf of Riga and the Baltic Proper.
2. The Skagerrak is a strait running between the southeast coast of Norway, the southwest coast of Sweden, and the Jutland peninsula of Denmark, connecting the North Sea and the Kattegat sea area, which leads to the Baltic Sea. The Kattegat is a sea area bounded by the Jutlandic peninsula and the Straits islands of Denmark on the west and south, and the southwest coast of Sweden, on the east.
3. The majority of economic activity in shipping, fisheries and aquaculture, and coastal industry (refinery and chemical industry located on the Swedish west coast) relate to the North Sea. The largest economic share of marine tourism and recreation is located in the Baltic Sea, while the other sectors have fairly equal shares between the North Sea and the Baltic Sea.
4. All industry with direct load to the sea.
5. For several sub-sectors in the maritime sector, no or little information is reported due to difficulties in identifying the maritime share of sectors that also have significant inland activities (SwAM, 2012a).
6. Nevertheless, actual employment in commercial fishing is expected to be slightly higher as not all personnel on vessels possess a commercial fishing licence.
7. Since Sweden does not have an official definition of marine or coastal tourism, the maximum value includes all tourism in the 85 coastal municipalities and islands, while the minimum value refers to tourism along the coastline only.
8. According to Swedish fisheries legislation, all legal fishing undertaken without a commercial fishing licence or an individual fishing right is classified as recreational fishing.
9. For example, a study assessed the value of recovering the cod population of the Baltic Sea at EUR 28 000 per year (Döring et al., 2005). HELCOM estimates the total annual value of the fish catch in the western part of the Baltic Sea to be EUR 1.5 billion (SEPA, 2009).
10. A study estimated the annual economic value per household of the MPAs established on Sweden's east and west coasts as SEK 500 and SEK 900 respectively (Östberg et al., 2011).
11. The International Council for the Exploration of the Sea (ICES) defines the ecosystem approach as "the comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity".
12. Although agreed rules for bycatch and discards already apply in Norwegian waters, the discard ban has not yet been implemented in Swedish and Danish waters due to incompatible EU rules that have yet to be modified.
13. In Sweden, MSP normally stands for "marine" spatial planning, while in the EU it stands for "maritime" spatial planning. There is no substantial difference in meaning.
14. An exclusive economic zone is a sea zone prescribed by the United Nations Convention on the Law of the Sea, over which a state has special rights regarding the exploration and use of marine resources, including energy production from water and wind. It stretches from a state's coastal baseline to 200 nautical miles (370.4 km) from the coast.
15. PES can be combined with existing natural resources regulation as a "top-up", where landholders can obtain compensation for undertaking more environmentally friendly action than the minimum regulation requires.

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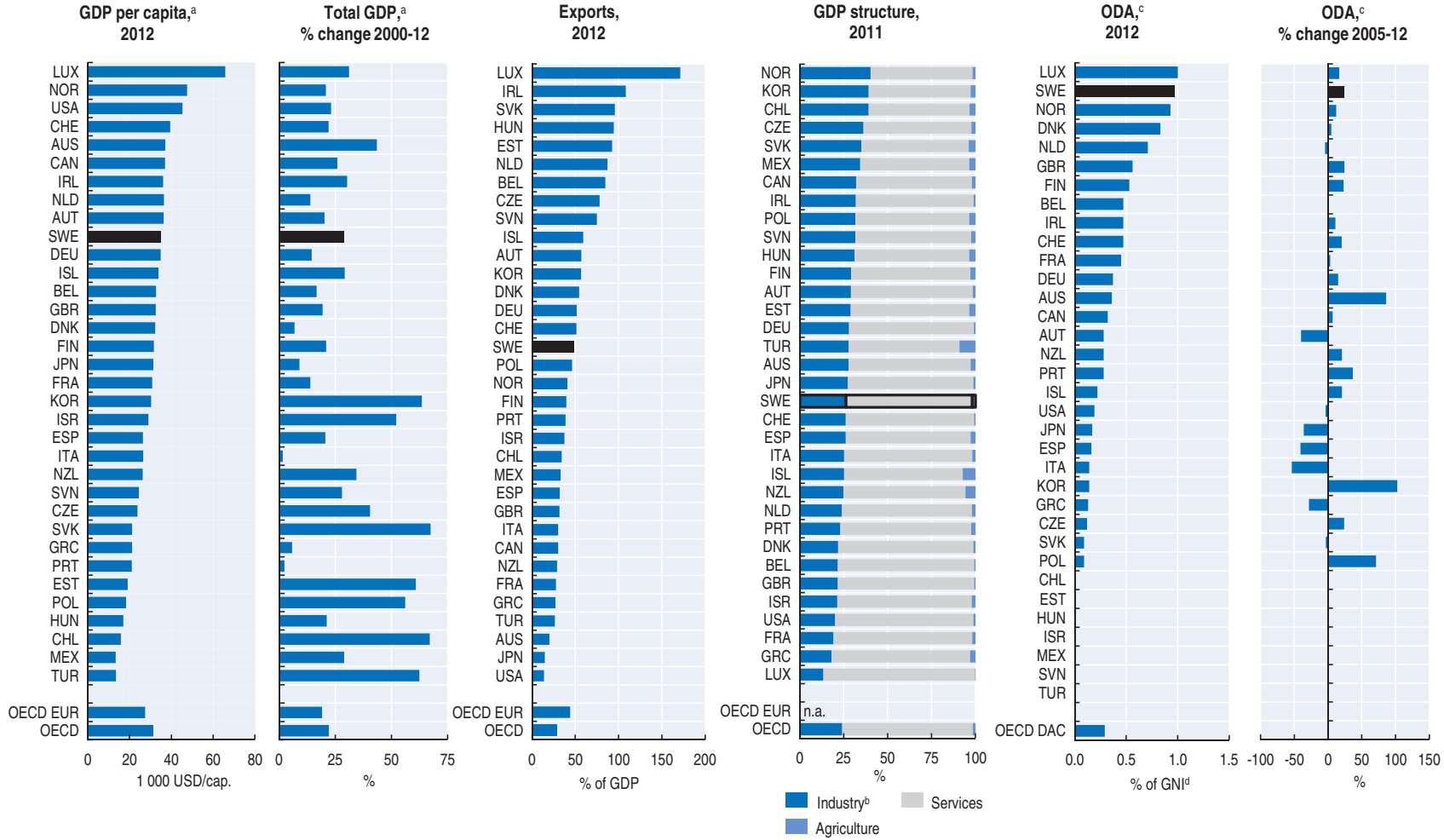
ANNEX I

*Selected data**

* The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Annex I.A. **Selected Economic Data*– Economic context**



*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.

a) GDP at 2005 prices and purchasing power parities.

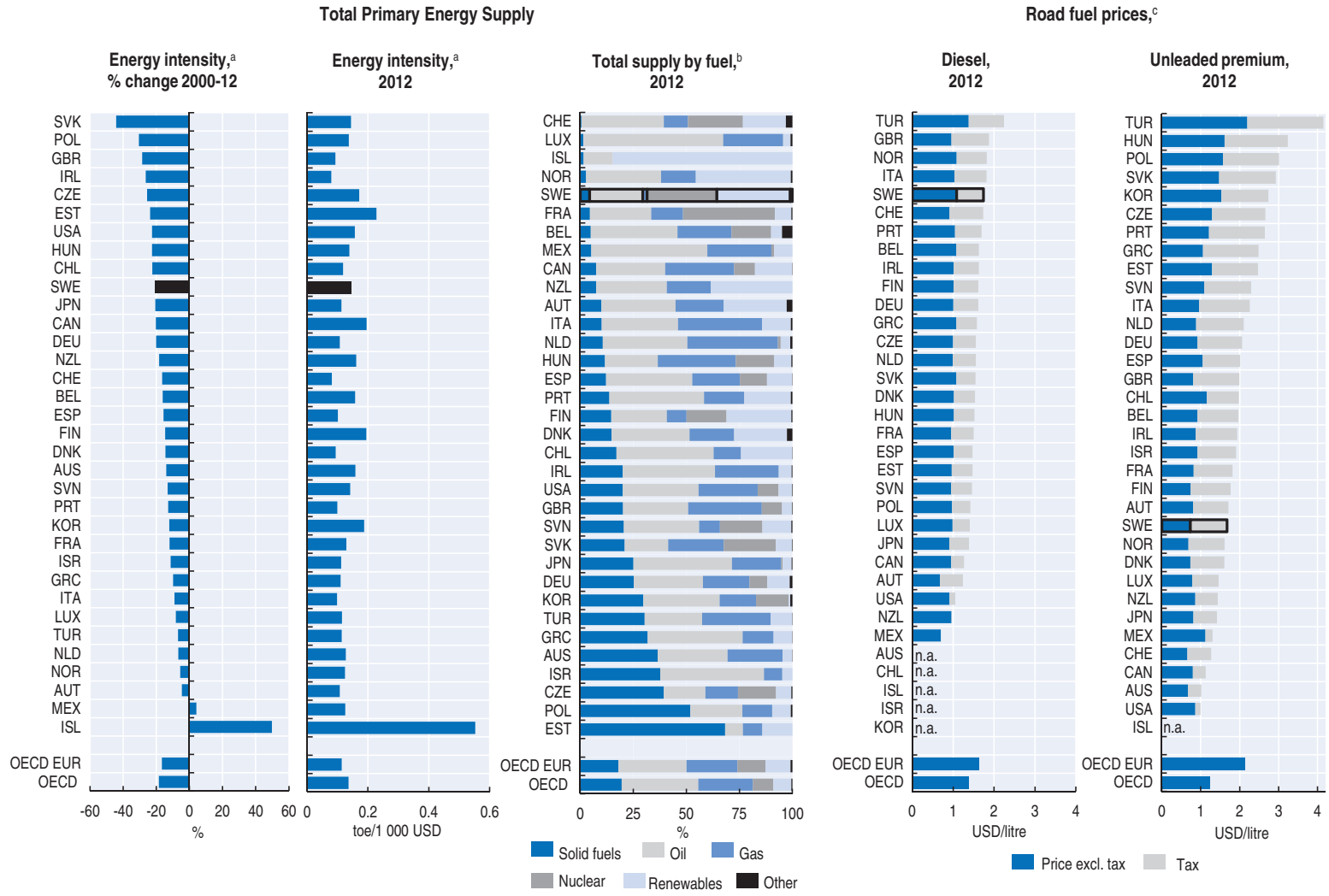
b) Includes mining and quarrying, manufacturing, gas, electricity and water, and construction.

c) Official development assistance by member countries of the OECD Development Assistance Committee. Total net disbursements at constant 2011 USD. CZE, ISL, KOR, POL and SVK became DAC members after 2005.

d) Gross national income.

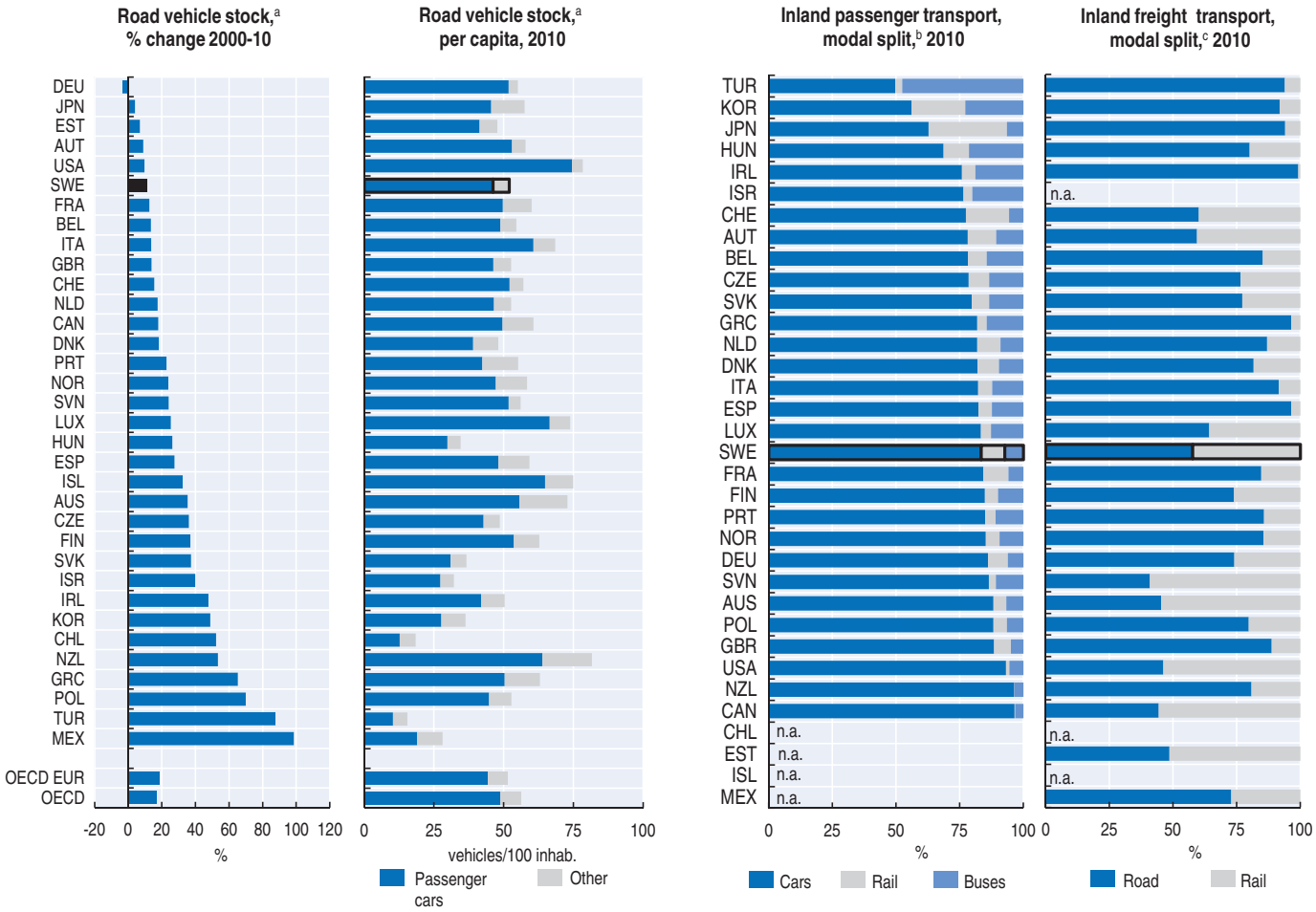
Source: OECD (2014), *OECD Environment Statistics* (database); OECD (2014), *OECD International Development Statistics* (database); OECD (2013), *OECD Economic Outlook No. 93* (database); OECD calculations.

Annex I.A. **Selected Economic Data*– Energy**



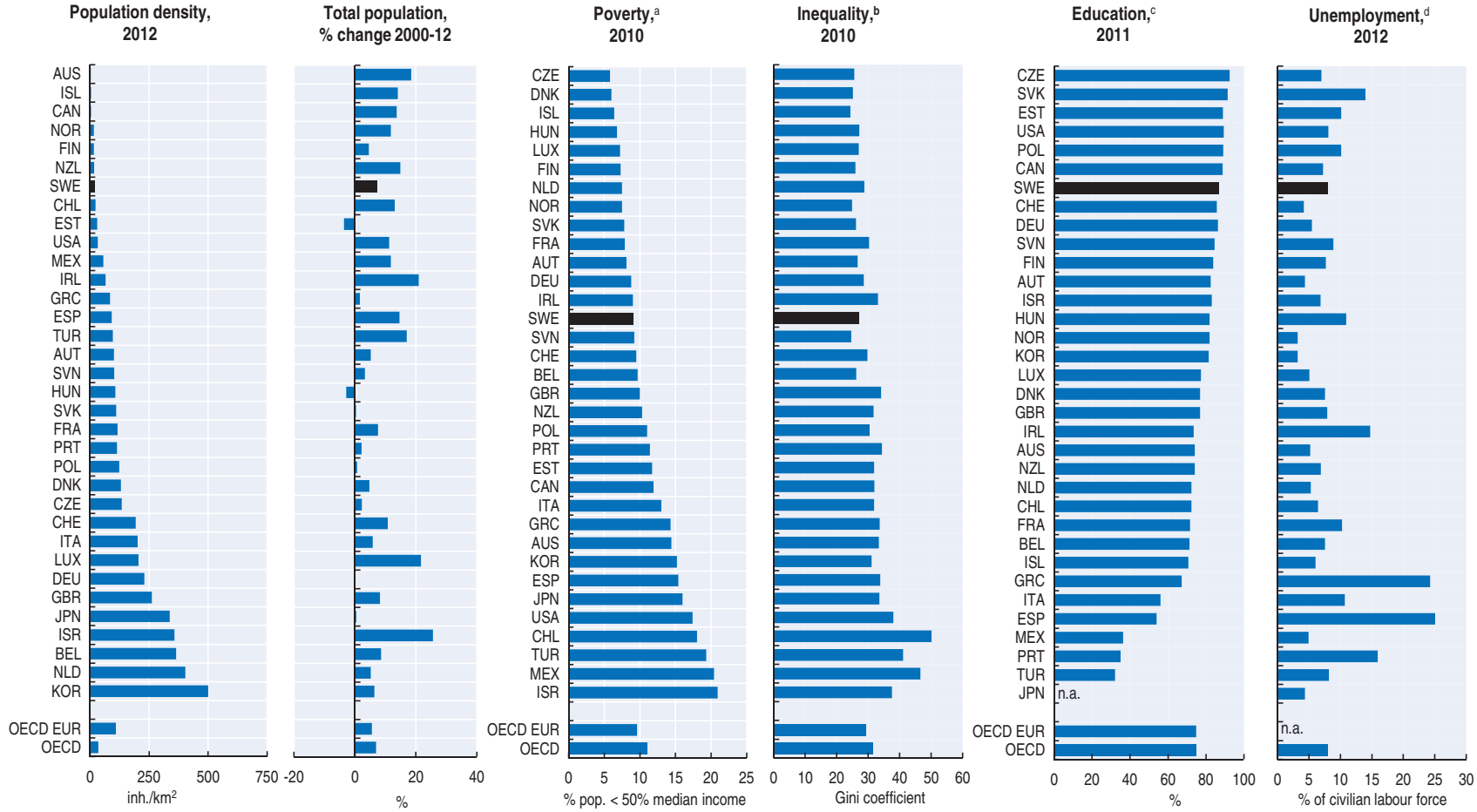
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.
a) Total primary energy supply per unit of GDP expressed at 2005 prices and purchasing power parities.
b) The breakdown excludes trade of electricity and heat.
c) Diesel fuel: automotive diesel for commercial use, current USD; unleaded petrol: unleaded premium (RON 95), except JPN (unleaded regular), USD at current prices and purchasing power parities.
Source: IEA (2014), *IEA Energy Prices and Taxes Statistics* (database); IEA (2013), *IEA World Energy Statistics and Balances* (database); OECD calculations.

Annex I.A. **Selected Economic Data*– Transport**



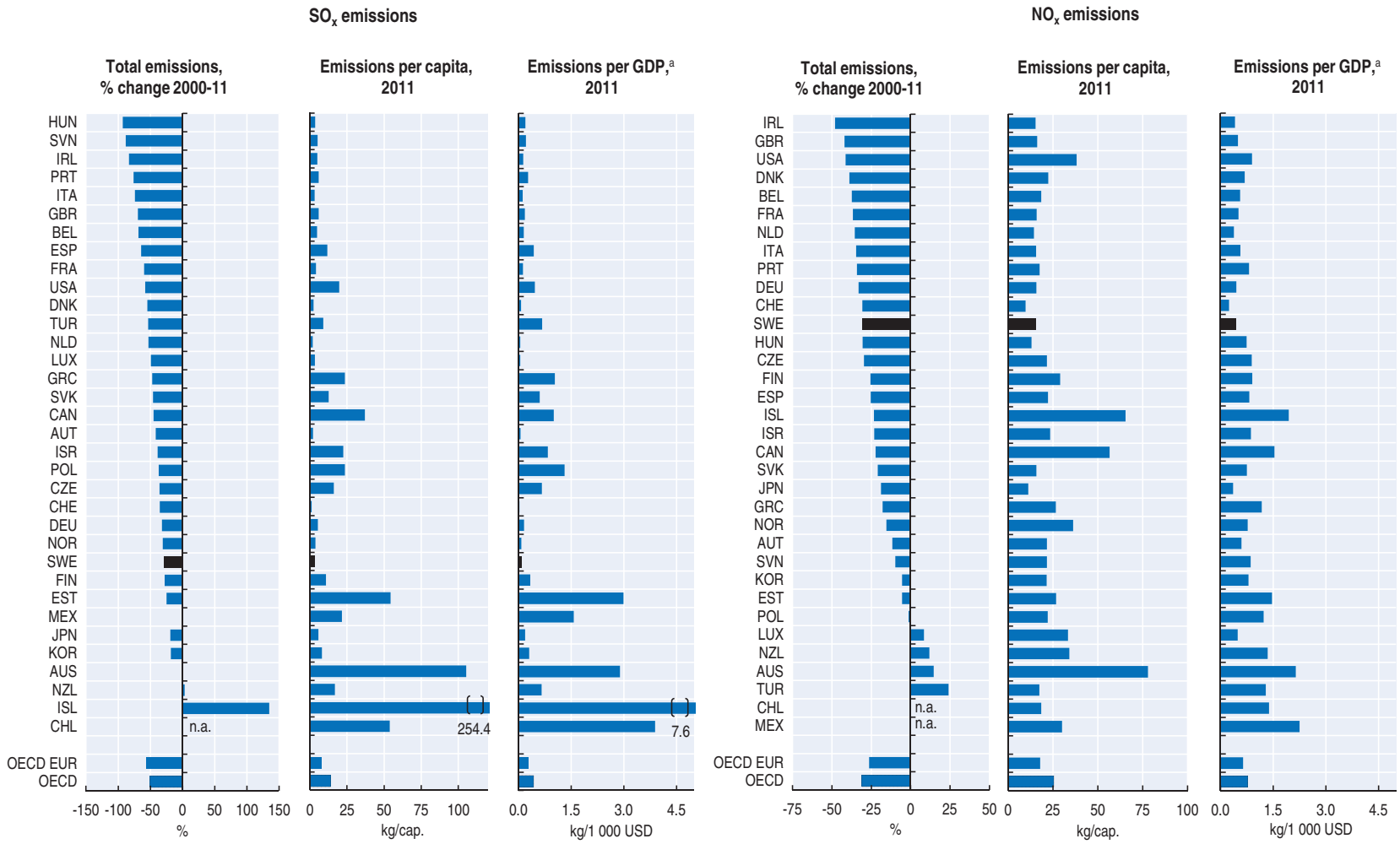
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.
a) Motor vehicles with four or more wheels.
b) Based on data expressed in passenger/km.
c) Based on value expressed in tonne/km.
Source: OECD (2014), *OECD Environment Statistics* (database).

Annex I.B. **Selected Social Data***



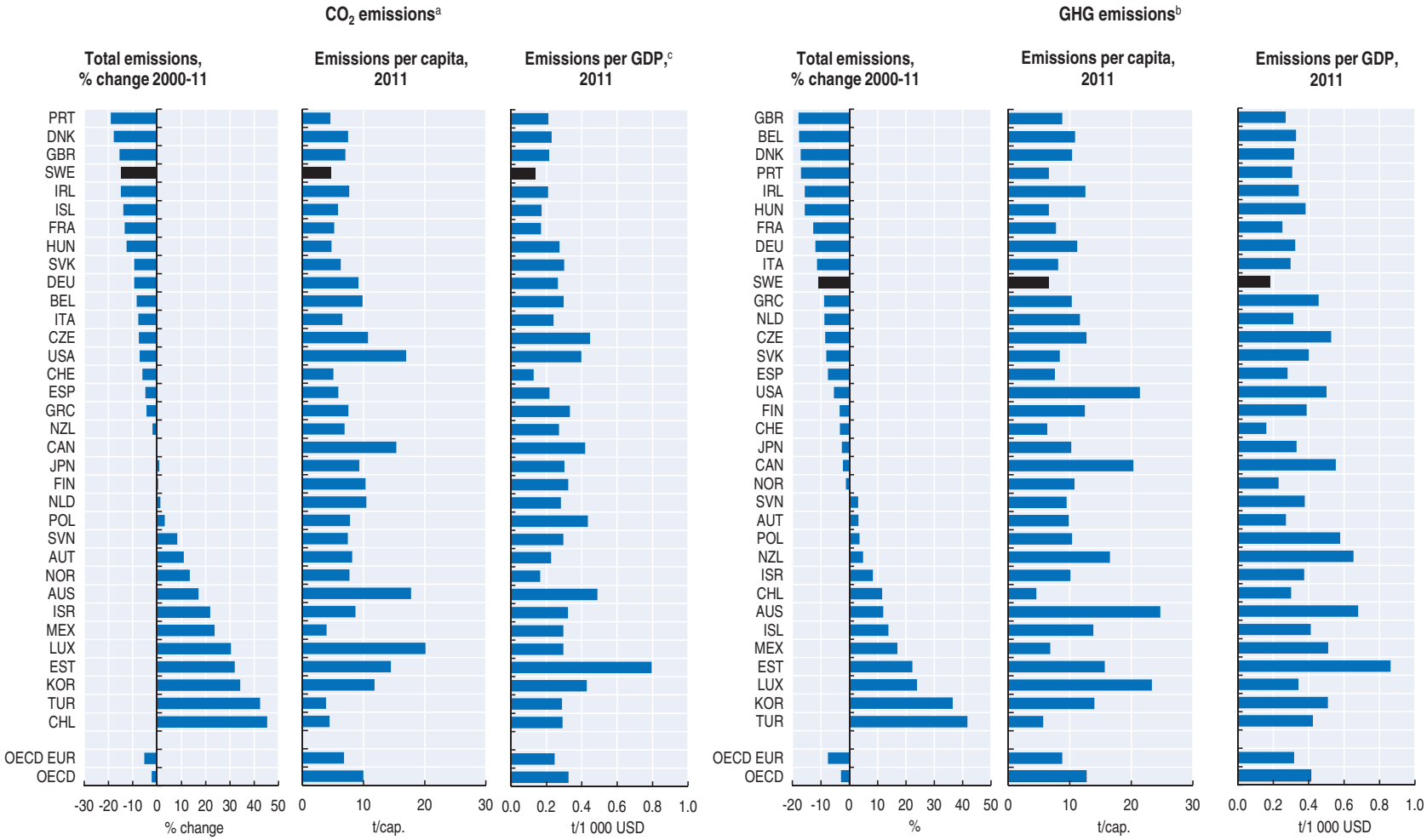
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.
a) Share of population with an income under 50% of the median income. OECD and OECD EUR: average of rates.
b) Ranging from 0 (equal) to 100 (inequal) income distribution, based on total disposable income (incl. all incomes, taxes and benefits) for the entire population. OECD and OECD EUR: average of rates.
c) Share of population aged 25-64 years with at least upper secondary education. OECD and OECD EUR: average of rates.
d) Harmonised unemployment rates.
Source: OECD (2014), *Main Economic Indicators*, *OECD Education Statistics, OECD Environment Statistics*, *OECD Social and Welfare Statistics* (databases).

Annex I.C. **Selected Environmental Data* – Air**



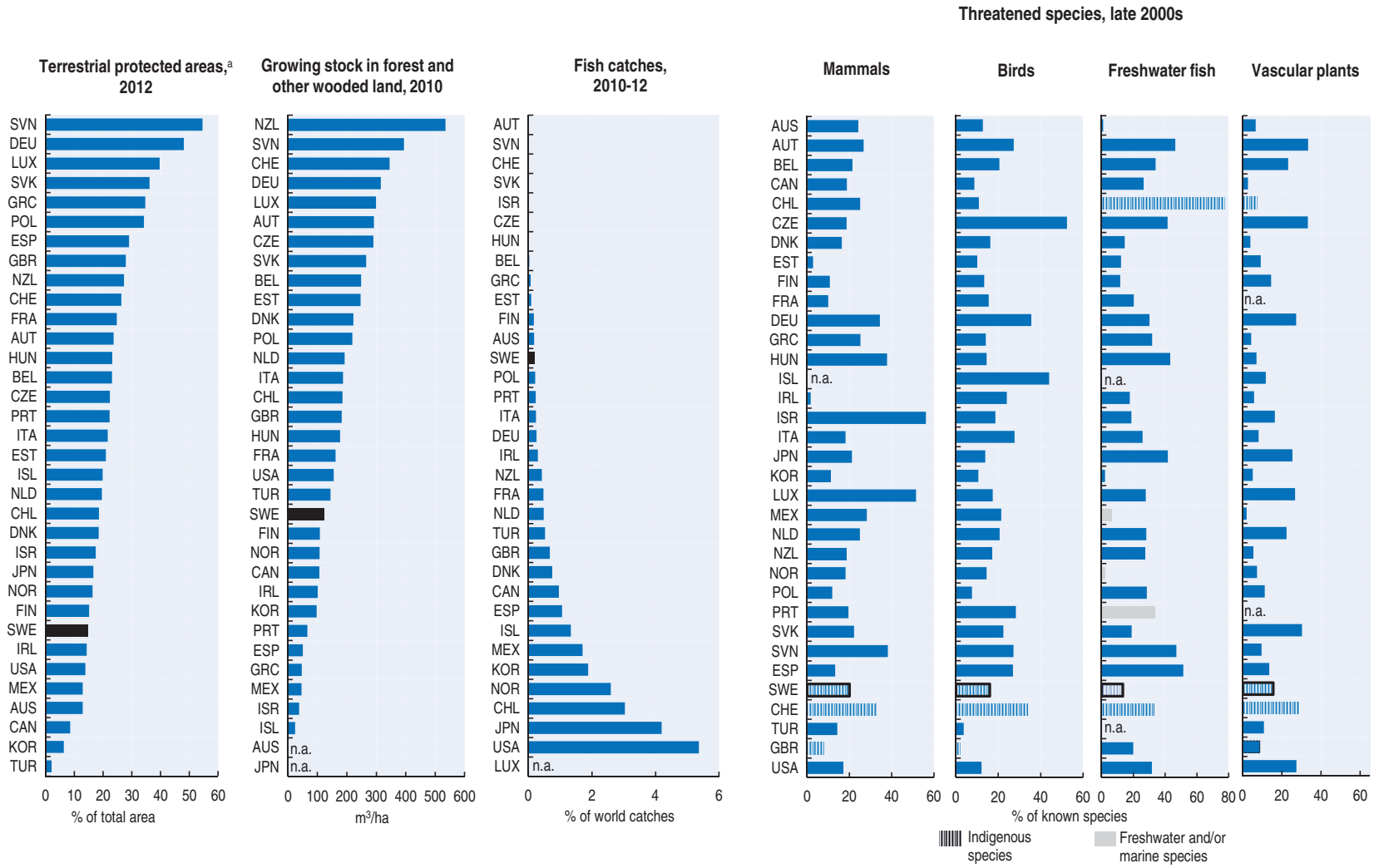
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Varying definitions can limit comparability across countries. Partial totals are indicated by dotted borders.
a) GDP at 2005 prices and purchasing power parities.
ISL: SO_x emissions include emissions from geothermal energy. LUX: NO_x emissions exclude emissions from "fuel tourism".
Source: OECD (2014); *OECD Environment Statistics* (database).

Annex I.C. **Selected Environmental Data* – Climate**



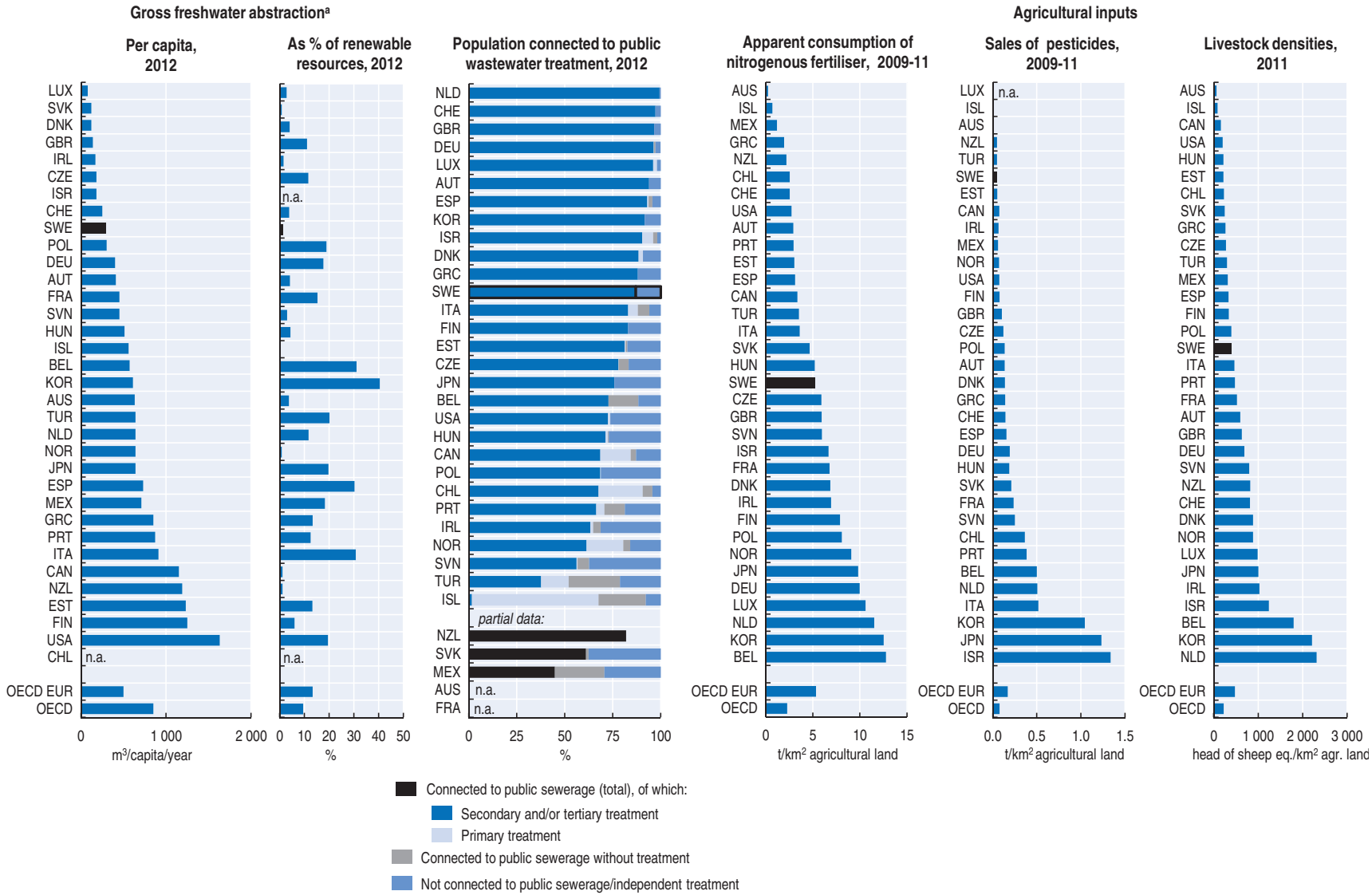
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.
a) Emissions from energy use only; excluding international marine and aviation bunkers; sectoral approach.
b) Excluding emissions/removals from land use, land-use change and forestry. ISR: 2000 data exclude F-gases.
c) GDP at 2005 prices and purchasing power parities.
Source: IEA (2013), *CO_2 Emissions from Fuel Combustion Statistics* (database); OECD (2014), *OECD Environment Statistics* (database); OECD calculations.

Annex I.C. **Selected Environmental Data* – Biodiversity conservation and sustainable use**



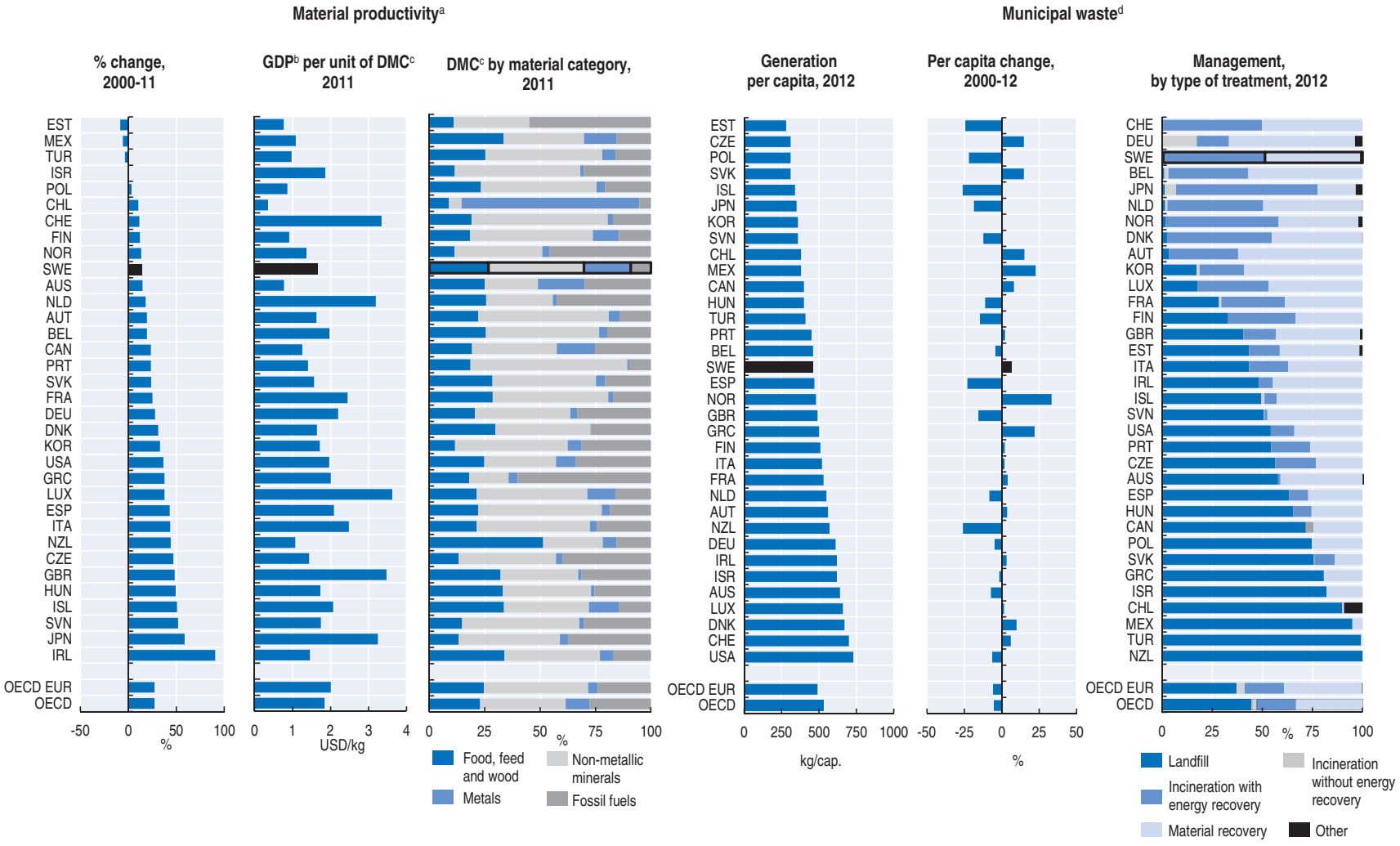
*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Varying definitions can limit comparability across countries.
a) Nationally designated terrestrial protected areas recorded in the World Database on Protected Areas (WDPA). National classifications may differ.
b) Threatened species: data referring to indigenous species are indicated by shaded areas.
Source: FAO (2014), *Global Capture Production* (database); FAO (2010), *Global Forest Resources Assessment 2010;* OECD (2014), *OECD Environment Statistics* (database); UNSTATS (2014), *Millennium Development Goals Indicators* (database).

Annex I.C. **Selected Environmental Data* – Water and land**



*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Partial totals are indicated by dotted borders.
a) For some countries, data refer to water permits and not to actual abstractions.
GBR: Water abstraction and public wastewater treatment: England and Wales only; pesticides use: Great Britain only.
Source: FAO (2014), *FAOSTAT* (database); OECD (2014), *OECD Environment Statistics* (database).

Annex I.C. **Selected Environmental Data* – Material productivity and waste**



*) Data refer to the indicated year or to the latest available year. They may include provisional figures and estimates. Varying definitions can limit comparability across countries. Partial totals are indicated by dotted borders.

a) Amount of GDP generated per unit of materials used, ratio of GDP to domestic material consumption (DMC).

b) GDP at 2005 prices and purchasing power parities.

c) DMC equals the sum of domestic (raw material) extraction used by an economy and its physical trade balance (imports minus exports of raw materials and manufactured products).

d) Waste collected by or for municipalities and includes household, bulky and commercial waste, and similar waste handled at the same facilities. CAN: household waste only and total incineration; NZL: landfilled waste only.

Source: OECD (2014), *OECD Environment Statistics* (database).

ANNEX II

Actions taken on selected recommendations from the 2004 OECD review

Recommendations	Actions taken
Policy-making environment	
1. Assure implementation of the Environmental Code across the country, strengthening guidance from the central government to regional and local authorities.	SEPA has issued a "Guidebook on Operational Inspection", which aims to ensure the relative uniformity of compliance monitoring practices across the country. A revised handbook "Management of environmental sanction charges" was published in 2011. All CABs were required to develop a plan for county administrative guidance for 2009-12. SEPA is required to submit an annual report to the government about the status of compliance monitoring and enforcement activities across the country (Chapter 2).
2. Evaluate the environmental effectiveness and economic efficiency of different policy instruments and mixes of policy instruments nationally and internationally and adjust policies accordingly.	Several different Swedish public authorities have published reports that analyse in more or less depth the environmental effectiveness and economic efficiency of different policy instruments and mixes of policy instruments, including climate-related taxes and green public procurement (Chapter 2).
3. Review, and revise as needed, state, regional and local inspection and enforcement roles, improving the monitoring and evaluation of environmental inspections, focusing enforcement on areas with the greatest compliance problems and strengthening administrative and judicial sanctions.	The 2011 Ordinance on environmental inspection and enforcement clarified the rules and responsibilities of different authorities at the central, regional and local levels. In particular, it strengthened the rules for CABs to delegate and withdraw compliance monitoring and enforcement responsibilities to and from local authorities. The Ordinance obliges every supervisory authority in Sweden to prepare a comprehensive annual inspection plan based on its compliance monitoring priorities, i.e. on those activities and installations that are important for meeting regional and local environmental targets. In 2007, the Committee on Public Sector Responsibilities concluded that inspections by local authorities have to be better coordinated (Chapter 2).
4. Give greater importance to environmental concerns in spatial planning by harmonising the provisions of the Environmental Code and the Planning and Building Act and by improving municipalities' implementation capacity.	The 2011 Planning and Building Act stipulated that planning must consider environmental and climate change-related aspects (e.g. potential risks of flooding, landslides and erosion) and the municipal comprehensive plans must describe how they intend to take account of national and regional goals, plans and programmes for sustainable development. In 2009, to strengthen local governments' capacity in this area, SEPA issued a handbook with general guidelines on environmental assessment of plans and programmes (Chapter 2).
5. Further encourage the use of standardised environmental management systems by companies.	The number of certifications to the ISO 14001 EMS standard grew by 73% in 2003-11, and the absolute number of certified installations is much greater than in other European countries with similar GDP levels. However, the number of EMAS registrations has decreased over the last five years despite the government's promotion programmes (Chapter 2).

Recommendations	Actions taken
6. Approve and implement the action strategy for the management of land, water and the built environment.	This strategy was approved, but was later superseded by the re-organisation of the EQO system. Recently, the All-Party Committee on Environmental Objectives developed strategies on sustainable land use and sustainable water policy, but the government has not yet adopted them (Chapter 2).
7. Strengthen institution-based integration among ministries and agencies, with particular attention to the integration of environmental concerns in industry, energy, transport, forestry and agricultural policy.	A total of 25 national agencies have responsibilities in the EQO system. The 2009 Ordinance required all 194 Swedish government agencies to have an ISO 14001 or EMAS-certified environmental management system that integrates environmental considerations into their activities (Chapter 2).
8. Develop economic information and analysis to support environmental management, streamline the system of environmental indicators.	National and regional EQO indicators are devised by the authority responsible for each EQO. The Regional Development and Co-operation in the Environmental Objectives System (RUS) has the primary responsibility to collect and maintain data on regional indicators. The Ministry of the Environment has given Statistics Sweden the task of assessing Sweden's progress towards sustainability with the help of the EU sustainability indicators compiled by Eurostat (Chapter 2). Sweden has further developed the environmental accounts. Information on environmental protection expenditure by industry, turnover, exports and employment in the environmental goods and services sector is updated regularly. Reporting on public expenditure on environmental protection is incomplete and cost-benefit analysis is insufficiently carried out (Chapter 2).
9. Enhance co-operation on economic, social and environmental dimensions of sustainable development within and between local, regional and national levels.	Environmental Collaboration Sweden (*Miljösamverkan Sverige*) is a partnership created in 2005 to include all the CABs, the SEPA and the National Board of Health and Welfare. This model of national-regional collaboration has been replicated in 11 of 21 Swedish counties through Regional Environmental Collaboration – a vehicle for sub-national-local co-operation between the CAB and the county's municipalities.
10. Ratify the Aarhus Convention and make the country's environmental information access, public participation and access to justice practices consistent with the convention's requirements.	Sweden ratified the Aarhus Convention in 2005. The 2005 Environmental Information Act guaranteed access to environmental information even in cases where this information is held by private entities executing public service functions. The Public Access to Information and Secrecy Act (2009) exempted information on pollution releases to the environment from the secrecy provisions under the earlier legislation. The Environmental Code's provisions concerning NGOs' right to appeal against environment-related decisions have been brought in line with the Aarhus Convention.
11. Further develop public participation and encourage citizen initiatives at regional and local levels.	NGOs obtained, under the 2011 Planning and Building Act, a right to be heard on matters related to local plans that have a significant environmental impact. NGOs are also important stakeholders in the design and implementation of the EQO system.
Towards green growth	
12. In deciding on any further green tax reform, give more consideration to using the lowest-cost opportunities to abate GHGs, while also taking into account long-term perspectives.	The energy and carbon tax rates have gradually been raised, and total and partial exemptions from these taxes have been progressively reduced. The increase in the carbon tax was compensated by a reduction of other taxes, especially on low-income households. To avoid overlaps between the carbon tax and the EU-ETS, installations covered by the ETS are exempted from the carbon tax. In 2006, Sweden introduced a CO_2-based annual vehicle tax for passenger cars, and in 2011 for light commercial vehicles. In 2007-09, a green car rebate (SEK 10 000) was available for purchases of environmentally friendly cars. In 2009, the green car rebate was superseded by a five-year exemption from vehicle tax for new green cars. Sweden has promoted the use of biofuels through total exemptions from the energy and CO_2 tax, but this measure has been costly (Chapters 3 and 4).
13. Reinforce efforts to remove remaining environmentally harmful subsidies.	In 2009 Sweden partially reformed the energy and carbon tax system to reduce exemptions (see recommendation 12), but fuels used in some sectors still benefit from total or partial exemptions. Also, the tax treatment of company cars and commuter allowances can provide perverse incentives (Chapter 3).

Recommendations	Actions taken
14. Review and revise transport prices to reflect all externalities, including damage associated with particulates, ozone and noise; implement road congestion charges in Stockholm and extend them to other major urban areas.	The municipalities of Stockholm and Gothenburg introduced a congestion charge (in 2007 and 2013, respectively). Heavy goods vehicles pay an annual road charge that varies with the size and environmental classification of the vehicle, but not with distance driven. No road toll applies to passenger cars. There is some evidence that pricing does not fully reflect the costs for the use of transport infrastructure, including environmental externalities. The annual vehicle tax takes account of CO_2 emissions (see recommendation 12). The energy tax on diesel is still lower than that on petrol (Chapters 3 and 4).
15. Introduce cost-effective demand management measures to decouple growth in municipal waste generation and road traffic from economic growth, in line with Objective 2 of the OECD Environmental Strategy.	Municipal waste charges are often based on one fixed rate for waste collection and one variable fee for waste treatment. The fee is normally volume-based, but 30 of 290 municipalities have introduced weight-based rates. Many municipalities introduced voluntary collection of food waste. The national waste plan 2012-17 emphasises waste prevention and sets new targets to reduce food waste generation. A national programme for waste prevention setting measures and objectives for key sectors was to be finalised by the end of 2013 (Chapter 3). See recommendation 14.
16. Continue active environmental employment policy, making it longer-term and focusing on specific economic sectors.	There is no explicit measure to promote environmental employment. Policy measures aim to promote the development and export of environmental technologies and services (Chapter 3).
17. Reinforce environmental sustainability aspects of current and future regional and rural development programmes.	About 70% of the Rural Development Programme 2007-13 was allocated to agri-environmental measures (e.g. for biodiversity protection, soil and water quality). There is a wide range of agri-environmental payments, which often overlap (Chapter 3).
18. Continue to integrate environmental concerns systematically into development assistance while maintaining or increasing overall levels of ODA.	Aid to the environment sector grew in the context of growing official development assistance flows. Significant commitments have been made to the objectives of the Rio conventions. In 2010, the government issued the Policy for Environmental and Climate Issues in Swedish Development Co-operation for the period to 2014. Environmental (including climate) screening is mandatory for all interventions (Chapter 3).
19. Increase environmental assistance and technology transfer to countries bordering the east of Baltic Proper, so as to promote the achievement of shared environmental objectives (e.g. regarding nutrient loads, acid precipitation, flexible mechanisms on climate change).	Swedish provided over SEK 2 billion in support to countries east of the Baltic for environmentally related activities over the past decade, mainly in the water and wastewater sectors, and for capacity building. The Swedish International Development Co-operation Agency's (Sida) support to Russia has focused on sustainable development of the Baltic Sea region and northwest Russia. A special Baltic Sea Unit was created in Sida to support cooperation in the region and to facilitate implementation of the 2009 EU Baltic Sea Strategy. Over 2005-11, SEK 67 million was granted to 199 projects related to the environment. The Baltic Sea Region Exchange Programme of the Swedish Institute for the Marine Environment financed 80 university and research collaboration projects with an environmental focus (SEK 29 million until 2011).
Climate change	
20. Pursue efforts towards enhanced energy efficiency; review in particular flexible mechanisms to maximise off-site life cycle energy saving opportunities.	The government has implemented several energy efficiency measures. Price signals through energy and CO_2 taxes and the EU ETS, complemented by information campaigns and counselling, influence energy demand and promote energy efficiency. The 2010-14 energy efficiency programme has an annual budget of SEK 300 million to support regional and local climate policy initiatives, green public procurement, and energy management; 180 public entities are required to save energy and report annually on their progress. Under the programme for improving energy efficiency in energy-intensive industry (PFE), introduced in 2004, if a company commits to an energy management system, energy audits and other measures to increase efficiency, it receives an exemption from the energy tax on electricity (Chapter 4).

Recommendations	Actions taken
21. Within the national climate protection programme, give priority to the most cost-effective instruments to promote energy conservation and the use of renewable energy sources, and review exemptions.	Sweden reformed the carbon and energy taxes to reduce exemptions (see recommendations 12 and 13). It joined the EU-ETS in 2005. The tradable electricity certificate system was introduced in 2003 to promote the generation of renewable electricity and combined heat and power. Other subsidy programmes have supported the use of renewables (biomass) for heating (Chapter 4).
Marine ecosystem services	
22. Pay particular attention to the needs of aquatic habitat and river basin management in implementation of the Water Framework Directive (WFD).	The regulation regarding the protection of biotopes was amended to better protect smaller aquatic habitats. River basin management plans (RBMPs) are closely linked to WFD requirements. The RBMPs currently lack information on final measures. Monitoring programmes are insufficient; not all relevant biological-quality elements are monitored and little biological monitoring appears to take place in water bodies.
23. Consider the need for further nitrogen removal in sewage treatment in inland and coastal areas and phosphorus removal in individual rural treatment systems.	In April 2007, the government announced that phosphorus would be prohibited in washing-up liquid and other detergents. The sale and supply of textile detergents containing phosphates to consumers for private use was prohibited on 1 March 2008; in July 2011, dishwasher detergents containing phosphates were also prohibited. A 2009 judgment of the Court of Justice of the European Communities required Sweden to upgrade 37 wastewater treatment plants for nitrogen removal. Work is ongoing to comply with the judgement.
24. Take further measures to reduce the impact of agriculture and forestry (e.g. nitrates, pesticides) on water systems and better protect streams and riverbanks inland, use practices related to agriculture and forestry.	Sweden has participated in several initiatives to reduce nutrient runoff into the Baltic Sea (e.g. Baltic Compass, Baltic Deal and Baltic Manure). The gross load from agricultural land of nutrients decreased (Chapter 1). Within the rural development programme (RDP), Sweden has made several changes to better meet the needs of reducing agricultural impact on water. These changes include new areas that qualify for agri-environmental payments (such as adapted buffer strips and controlled drainage), additional areas to the nitrate vulnerable zone and new restrictions on manure spreading. New rules from 2005 include restrictions for farmers within and outside nitrate vulnerable zones. Implementing the sustainable use of pesticides directive (SUD) increases inspection of equipment use and integrated plant protection management. Some actions that were formerly voluntary are now mandatory. In 2011, a national strategy was developed to monitor and address the effects of phasing out pesticides.
25. Further improve the knowledge base for nature conservation and biodiversity management (e.g. inventory of key habitats, indicators, economic analysis), especially regarding aquatic and marine ecosystems.	In 2005, the objective "A rich diversity of plant and animal life" was added to the EQO system. Extensive resources have been invested in habitat inventories, monitoring and management practices. A baseline inventory of protected areas and Natura 2000 sites was conducted in 2008. Extensive inventories have been made of freshwater habitats and marine habitats on offshore banks in some counties. Several authorities are carrying out government assignments relating to ecosystem services and green infrastructure. A nationwide monitoring system for species and habitats of EU interest has also been initiated. In 2007, the government instructed SEPA to compile information focusing on the economic implications of human impacts on the Baltic Sea and Skagerrak. In 2009 SEPA released several reports on this issue (Chapter 4).
26. Further increase the extent of protected areas and their representativeness (e.g. nonmountain forests, marine and freshwater ecosystems).	About 14% of Swedish land area and 6% of territorial sea are under some form of nature protection. The most common types of protected area and Natura 2000 site are mountain areas and forests (Chapters 1 and 5). Various wetlands have also been protected, such as Tervavuoma nature reserve and Kosterhavet national park (Chapter 5).

Recommendations	Actions taken
27. Strengthen the management and restoration of streams, wetlands and meadow lands within a broader landscape policy.	Since 2007, Sweden has continued to restore and re-establish wetlands in areas of arable land. Although 10 000 hectares have been restored, a further 2 000 hectares remain to be completed. Limited restoration measures have been taken in mires surrounded by forests. Funds still remain inadequate for haymaking and grazing in rich fens and on peat lands along rivers. Landscape strategies and green infrastructure projects have been implemented in certain project areas, but have not been expanded.
28. Finalise and implement a programme for integrated coastal zone management and strengthen local planning authorities' capacity in coastal zone protection.	The Swedish Agency for Marine and Water Management (SwAM) is responsible for marine spatial planning. The new state marine planning system integrates environmental issues; the protection of shores, banks and beaches has been strengthened where development pressures are greatest. More comprehensive planning now comprises both land and water areas and highlights coastal issues. The effects of climate change and wind power development are now commonly included in planning (Chapter 5). A large number of websites and web portals with information for planning and management of coastal areas has been established in recent years. Protection of shores, banks and beaches has been refined in the Environmental Code and in the Planning and Building Act (Chapter 2).
29. Adopt and implement a national marine strategy: in particular, take further measures to reduce nitrogen loading to the Baltic Sea so as to meet the HELCOM target for 2005, as well as related national targets; step up preventive actions and sanctions concerning oil spills; take measures to strengthen regional co-operation for fishery management, working through the International Baltic Sea Fishery Commission and the EU; develop a ship scrapping plan.	A new policy for integrated and comprehensive maritime management was approved and the SwAM was established in 2011. Sweden established 19 marine protected areas and 6 no-fishing zones (see recommendation 26). The government allocated SEK 500 million up to 2010 for actions to protect and restore the Baltic Sea (Chapter 5). Since 2004 Sweden has enacted stricter legislation on pollution from ships, as well as increased fines for these types of offences. The Coast Guard has expanded its surveillance. Sweden established the Swedish Institute for the Marine Environment to provide scientific support to policy making. SEPA drafted a comprehensive action plan for the marine environment in 2005. HELCOM Baltic Sea Action Plan (BSAP) was adopted in Krakow in November 2007 (Chapter 5). Within the plan, Sweden recommended more stringent phosphorus limits for wastewater treatment plants. See recommendations 23 and 24. There is no advancement on a ship scrapping plan.
30. Build on the recent International Maritime Organization designation of the Baltic as a "particularly sensitive sea area" and continue to promote regional action to decrease emissions to air of SO_x, VOCs and NO_x from ships in the Baltic, with an emphasis on economic instruments.	A new fairway-dues system entered into force in 2005, with charges differentiated according to ships' environmental performance. Requirements for vapour recovery systems were introduced as a condition for loading and unloading products with VOCs to and from ships. There are currently no measures to steer traffic from protected areas outside the coastal areas (Chapter 5). Sulphur regulation (SECA) will soon be approved and subsequently introduced in the Baltic region in 2015. Discussions concerning nitrogen regulation (NECA) are taking place; regulations will possibly be introduced in 2018. A ban on emissions of black and grey water from recreational crafts will enter into force in 2015. A similar ban will apply to shipping once the reception capacity has been developed in ports, but no later than 2018.

ANNEX III

Abbreviations

BSAP	HELCOM Baltic Sea Action Plan
CAB	County administrative board
CAP	European Union's Common Agriculture Policy
CeMEB	Linnaeus Centre for Marine Evolutionary Biology
CFP	European Union's Common Fisheries Policy
CHP	Combined heat and power
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO_2	Carbon dioxide
DAC	OECD Development Assistance Committee
DDT	Dichlorodiphenyltrichloroethane
DMC	Domestic material consumption
EC	European Commission
EEA	European Environment Agency
EEZ	Exclusive economic zone
EGSS	Environmental goods and services sector
EIA	Environmental impact assessment
EIONET	European environment information and observation network
ELD	EU Environmental Liability Directive
EMAS	EU Eco-Management and Audit Scheme
EMS	Environmental management system
EPD	Environmental product declaration
EPHC	Environmental and public health committee
EPO	European Patent Office
EQOs	Environmental quality objectives
ESD	EU Effort Sharing Decision
ETS	Emissions trading system
EU	European Union
EUA	EU CO_2 allowances
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
Formas	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FSC	Forest Stewardship Council

GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
GES	Good environmental status
GFT	Government financial transfer
GHG	Greenhouse gas
GNI	Gross national income
GPP	Green public procurement
GRI	Global Reporting Initiative
HCB	Hexachlorobenzene
HELCOM	Baltic Marine Environment Protection Commission
ICAO	International Civil Aviation Organization
ICES	International Council for the Exploration of the Sea
ICMZ	Integrated coastal zone management
IEA	International Energy Agency
IMO	International Maritime Organization
IMP	Integrated marine policy
INSPIRE	EU Directive establishing an Infrastructure for Spatial Information
ITF	International Transport Forum
ITR	Implicit tax rate
JPO	Japan Patent Office
KLIMP	Local climate investment programmes
LIP	Local investment programmes
LUCID	Lund University Centre of Excellence for Integration of Social and Natural Dimensions of Sustainability
LULUCF	Land use, land-use change and forestry
MFA	Ministry for Foreign Affairs
MPA	Marine protected area
MSFD	EU Marine Strategy Framework Directive
MSP	Marine spatial planning
MW	Megawatt
NAO	National Audit Office
NBHBP	National Board of Housing, Building and Planning
NEC	EU National Emissions Ceilings Directive
NECA	Nitrogen regulation
NGO	Non-governmental organisation
NO_x	Nitrogen oxides
ODA	Official development assistance
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAHs	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyl
PCDD	Polychlorinated dibenzodioxin
PES	Payment for ecosystem services
PFE	Programme for improving energy efficiency in energy-intensive industry
PISA	OECD Programme for International Student Assessment
PM	Particulate matter
POP	Persistent organic pollutant

PV	Photovoltaic
PVC	Polyvinyl chloride
R&D	Research and development
RBMP	River basin management plan
RDP	Rural development programme
RIA	Regulatory impact assessment
RUS	Regional Development and Co-operation in the Environmental Objectives System
SALAR	Swedish Association of Local Authorities and Regions
SCB	Statistics Sweden
SEA	Strategic environmental assessment
SECA	Sulphur regulation
SEK	Swedish krona
SEMCo	Swedish Environmental Management Council
SEPA	Swedish Environmental Protection Agency
SFA	Swedish Forest Agency
Sida	Swedish International Co-operation Agency
SIKA	Swedish Institute for Transport and Communications Analysis
SME	Small- and medium-sized enterprise
SMHI	Swedish Meteorological and Hydrological Institute
SO_x	Sulphur oxides
SUD	Sustainable Use of Pesticides Directive
SwAM	Swedish Agency for Marine and Water Management
Swentec	Swedish Environment Technology Council
TFC	Total final consumption of energy
TPES	Total primary energy supply
TREC	Tradable electricity certificate
TWh	Terawatt-hours
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
USD	United States Dollar
USPTO	United States Patent and Trademark Office
VOC	Volatile organic compound
WFD	EU Water Framework Directive
WHO	World Health Organization
WTP	Willingness to pay

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