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Preface

This third *Environmental Performance Review* of Switzerland examines the progress made in achieving the country's environmental objectives since the OECD's previous review, published in 2007. Much has changed since then. Just last May, on 21 May 2017 precisely, the Swiss population voted "yes" on a government proposal to revise the Energy Act to allow a gradual phase-out of nuclear energy while increasing reliance on local renewable energy sources. This is expected to lead to investment and jobs in Switzerland, benefiting not only the environment, but also the population and the economy. The Swiss carbon tax has been increased last year to EUR 77 per tonne and compares very favourably with that in the few OECD countries which introduced such a tax. The Swiss Emissions Trading Scheme will soon be linked to that of the European Union after a long negotiation period.

There have also been significant efforts undertaken by Switzerland to improve the environmental performance of its agricultural sector. In particular, in recent years, a large share of payments under the agricultural policy have been explicitly devoted to the protection of farm biodiversity and the Swiss landscape. Switzerland has also been proactive in the field of transport. It is one of three OECD countries that tax diesel at a higher rate than petrol. A modal shift of freight from road to rail is encouraged through road pricing for heavy goods vehicles and, with the December 2016 opening of the Gotthard Base Tunnel, the world's longest rail tunnel.

On some environmental scores, Switzerland comes out rather well. Most notably, the country is a top OECD performer in terms of greenhouse gas emissions intensity as well as material productivity. Switzerland should also be commended for its innovative approach to strengthening the nexus between water and biodiversity. In particular, since 2011, with the in-depth revision of the Water Protection Act, it has embarked on a long journey towards the "renaturation" of its rivers. This is a fascinating example of a policy initiative that crosses many boundaries since it deals not only with water and biodiversity policy but also energy policy and land use planning.

Recent polling showed that a large majority of Swiss believe the environment in Switzerland is doing very well. However, there is plenty to suggest that Swiss satisfaction with the environment is disconnected from the reality of the situation. Municipal waste has increased by 27% since 2000, in line with private final consumption. Switzerland has some of the highest percentages of threatened species across OECD countries, including mammals. Half the 20 largest Swiss lakes still suffer from eutrophication and lack of oxygen, some of them to the point of having to be artificially ventilated.

Beyond that, Switzerland has a huge ecological footprint associated with unsustainable consumption patterns. Swiss consumption is imposing significant pressure far beyond its borders. The Green Economy Action Plan, which Switzerland adopted in 2013, recognises the need for a shift towards more sustainable consumption patterns consistent with living within the planet's limits.

This Review presents 42 recommendations to strengthen Switzerland's environmental policies and performance. I hope that it will also make a useful contribution to current efforts to improve policy coherence and promote the environment as a source of economic growth.

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 Switzerland's environmental performance since the second review in 2007. 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 Switzerland'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 Switzerland for its co-operation in providing information, for the organisation of the review mission to Bern (28-30 November 2016) and for facilitating contacts both inside and outside government institutions.

Thanks are also due to the representatives of the Czech Republic, Lukáš Pokorný, and of the European Commission, Rayka Hauser (Directorate-General for Environment) for examining Switzerland's environmental performance.

The authors of this report were Gérard Bonnis, Raphaël Jachnik, Aleksandra Paciorek and Alexa Piccolo (all OECD Secretariat), Félix-A. Boudreault and Rachel Samson (consultants). Nathalie Girouard provided oversight and guidance. Mauro Migotto provided statistical support; Annette Hardcastle provided editorial and administrative support; and Rebecca Brite copy-edited the report. Preparation of this report also benefited from inputs and comments from several members of the OECD Secretariat, including Joëlline Bénéfice, Jane Ellis, Florens Flues, Guillaume Gruère, Katia Karousakis, Xavier Leflaive, Patrice Ollivaud, Ronald Steenblik, Simon Upton, Kurt Van Dender, Václav Vojtech and Frédérique Zegel.

The OECD Working Party on Environmental Performance discussed the draft Environmental Performance Review of Switzerland at its meeting on 27 June 2017 in Paris, and approved the Assessment and Recommendations.

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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, Latvia, 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: CHF

In 2016, USD 1.00 = CHF 0.99

In 2015, USD 1.00 = CHF 0.96

In 2014, USD 1.00 = CHF 0.92

Cut-off date

This report is based on information and data available up to September 2017.

Disclaimer

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This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Abbreviations and acronyms

ACT	Swiss Cleantech Agency
ARE	Federal Office for Spatial Development
BAT	Best available techniques
BDM	Swiss Biodiversity Monitoring
BMW	Biodegradable municipal waste
CBD	Convention on Biological Diversity
CCE	Conference of Heads of Environmental Protection Services
CCHydro	Climate Change and Hydrology
CCSU	OECD Climate Change Sector Understanding
CEDRIG	Climate, Environment and Disaster Risk Reduction Integration Guidance
CHM	Clearing-House Mechanisms
CO_2	Carbon dioxide
DAC	Development Assistance Committee (OECD)
DETEC	Federal Department of the Environment, Transport, Energy and Communications
DMC	Domestic material consumption
EAER	Federal Department of Economic Affairs, Education and Research
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
ECA	Ecological compensation area
ECC	Environmental cross-compliance
EEA	European Environment Agency
EHS	Environmentally harmful subsidies
EIA	Environmental impact assessment
EnAW	Energy Agency for Economy
EPA	Environmental Protection Act
EPE	Environmental protection expenditure
EPR	OECD Environmental Performance Review
EQS	Environmental quality standards
ERT	Environmentally related taxes
ESG	Environmental, social and governance
ETS	Emission trading system
FDI	Foreign direct investment
Federal Assembly	Swiss parliament
Federal Council	Swiss government
FIT	Feed-in tariff
FOAG	Federal Office for Agriculture
FOEN	Federal Office for the Environment
FOT	Federal Office of Transport
FSO	Federal Statistical Office
GBR	General binding rules
GDP	Gross domestic product
GEAP	Green Economy Action Plan
GEF	Global Environment Fund
GHG	Greenhouse gas
GNI	Gross national income

GPP	Green public procurement
HNIs	Habitats of national importance
HODUFLU	Farm manure management
HPP	Hydropower plants
ICPR	International Commission for the Protection of the Rhine
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
INDC	Intended Nationally Determined Contributions
IPBES	Intergovernmental Panel on Biodiversity and Ecosystem Services
IUCN	International Union for Conservation of Nature
KELS	Climate and Energy Incentive System (known by the German acronym)
KliK	Foundation for Climate Protection and Carbon Offset
MNE	Multinational Enterprises
MONET	Monitoring of Sustainable Development
MSW	Municipal solid waste
Mtoe	Million tonnes of oil equivalent
NAQUA	National Groundwater Monitoring
NAWA	National Surface Water Quality Monitoring Network
NCHA	Act on the Protection of Nature and Cultural Heritage
NGO	Non-governmental organisation
NH_3	Ammonia
NO_X	Nitrogen oxide
OAPC	Ordinance on Air Pollution Control
ODA	Official development assistance
OSPAR Convention	Convention for the Protection of the Marine Environment of the North-East Atlantic
PM	Particulate matter
R&D	Research and development
Reffnet.ch	Swiss Network for Resource Efficiency
REPIC	Renewable Energy and Energy Efficiency Promotion in International Cooperation
RES	Renewable energy supply
RIA	Regulatory impact assessment
SA	Sustainability assessment
SDC	Swiss Agency for Development and Co-operation
SDS	Sustainable Development Strategy
SEA	Strategic environmental assessment
SECO	State Secretariat for Economic Affairs
SFOE	Swiss Federal Office of Energy
SIB	Swiss Information System Biodiversity
SLC	Swiss Landscape Concept
SME	Small and medium-sized enterprise
SNSF	Swiss National Science Foundation
SO_2	Sulphur dioxide
SPA	Spatial Planning Act
SSIGE	Swiss Gas and Water Industry Association

TFC	Total final consumption
TPES	Total primary energy supply
UAA	Utilised agricultural area
UNECE	United Nations Economic Commission for Europe
VAT	Value-added tax
VOC	Volatile organic compound
WDP	Water drainage plan
WPA	Waters Protection Act
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research

BASIC STATISTICS OF SWITZERLAND (2015 or latest available year)*

(OECD values in parentheses)

PEOPLE AND SOCIETY

Population (million)	8.1	(1 274)	Population density per km^2	196.9	(35.1)
Share of population by type of region:[a]			Population compound annual growth rate, latest 5 years	0.8	(0.6)
Predominantly urban (%)	60.6	(45.2)	Income inequality (Gini coefficient)	0.28	(0.32)
Intermediate (%)	36.2	(34.5)	Poverty rate (% of population with less than 50% of med. income)	9.1	(11.3)
Rural (%)	3.3	(25.7)	Life expectancy	83.3	

ECONOMY AND EXTERNAL ACCOUNTS

Total GDP (national currency, billion)	646		Imports of goods and services (% of GDP)	51.2	(28.5)
Total GDP (USD, billion, current PPPs)	506	(51 188)	Main exports (% of total merchandise exports)		
GDP compound annual real growth rate, latest 5 years	1.5	(1.7)	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin	30.5	
GDP per capita (1 000 USD current PPPs)	62.3	(40.2)	Pharmaceutical products	20.8	
Value added shares (%)			Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	7.9	
Agriculture	0.7	(1.8)	Main imports (% of total merchandise imports)		
Industry including construction	25.5	(24.8)	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin	34.4	
Services	73.8	(73.4)	Pharmaceutical products	8.6	
Exports of goods and services (% of GDP)	62.9	(28.9)	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	7.0	

GENERAL GOVERNMENT

Percentage of GDP[b]

Expenditure	33.9	(41.8)	Education expenditure	6.0	(5.3)
Revenue	35.0	(38.7)	Health expenditure	2.3	(7.6)
Gross financial debt	45.2	(113.2)	Environmental protection expenditure	0.7	(0.5)
Fiscal balance	1.1	-(3.1)	Environmentally related taxes: (% of GDP)	1.8	(1.6)
			(% of total tax revenue)	6.6	(5.2)

LABOUR MARKET, SKILLS AND INNOVATION

Unemployment rate (% of civilian labour force)	4.2	(7.3)	Patent applications in environment-related technologies (% of all technologies, average of latest 3 years)[c]	8.7	(11.7)
Tertiary educational attainment of 25 to 64 years-olds (%)	41.7	(35.0)	Environmental management	2.7	(4.4)
Gross expenditure on R&D, % of GDP	3.0	(2.4)	Water-related adaptation technologies	0.9	(0.5)
			Climate change mitigation technologies	6.7	(9.4)

ENVIRONMENT

Energy intensity: TPES per capita (toe/cap.)	3.0	(4.1)	Road vehicle stock (veh./100 inhabitants)	73.5	(68.2)
TPES per GDP (toe/1 000 USD, 2010 PPPs)	0.1	(0.1)	Water stress (abstraction as % of available resources)	3.8	(9.7)
Renewables (% of TPES)	22.4	(9.6)	Water abstraction per capita (m^3/cap./year)	249	(819)
Carbon intensity (energy-related CO_2):			Municipal waste per capita (kg/capita)	742	(520)
per capita (t/cap.)	4.7	(9.4)	Material productivity (USD, 2010 PPPs/DMC, kg)	4.3	(1.7)
per GDP (t/1 000 USD, 2010 PPP)	0.09	(0.26)	Land area (1 000 km^2)	40	(34 404)
GHG intensity:[d]			% of arable land and crops	10.8	(12.2)
per capita (t/cap.)	6.0	(12.4)	% of permanent meadows and pastures	27.8	(23.4)
per GDP (t/1 000 USD, 2010 PPP)	0.11	(0.34)	% of forest area	31.6	(31.3)
Mean population exposure to air pollution ($PM_{2.5}$), µg/m^3	12.5	(14.5)	% of other land (built-up and other land)	29.8	(33.1)

* Values earlier than 2010 are not taken into consideration. OECD value is a simple average of available countries b) OECD value: where the OECD aggregate is not provided in the source database, a simple OECD average of the latest available data is calculated. c) Higher-value inventions that have sought patent protection in at least two jurisdictions. Average of latest 3 years d) Excluding emissions/removals from land use, land-use change and forestry. Source : Calculations based on data extracted from databases of the OECD, IEA/OECD, EUROSTAT and the World Bank.

Executive summary

Improved environmental performance but not in all domains

Against the backdrop of economic growth in line with that of the OECD average since 2000, Switzerland has made progress in decoupling by reducing emissions of greenhouse gases (GHG) and other main atmospheric pollutants, curtailing freshwater abstraction and enhancing material productivity. Energy consumption is decreasing and becoming less intensive. There is an increasing modal shift of freight from road to rail. Half of municipal waste is recycled. Well-being perception is generally high.

Nevertheless, a number of environmental pressures remain. Municipal waste generation is rising. Eutrophication affects water quality in many lakes. Use of agricultural nitrogen inputs remains excessive and results in nitrogen deposition beyond critical loads for ecosystems. Mostly dyked Swiss streams struggle to fulfil their natural functions. More than one-third of species are threatened and few habitats of national importance are strictly protected. Still waters, shores and wetland ecosystems are threatened. Land take is gaining pace, especially on the outskirts of cities, fragmenting habitats and diminishing biodiversity. Concentrations of NO_2 and particulates in the air are still above the legal ambient limit values in areas of heavy traffic and there are peaks of summer ozone in some rural areas.

Environmental democracy but implementation gaps on the ground

Switzerland has a long tradition of direct democracy through referendums and popular initiatives, which are useful in giving an impulse to policy making. Switzerland also has a well-developed system of *ex ante* evaluation of environmental policy, including assessments of cost-effectiveness, regulatory impact and sustainability, while strategic environmental assessment has yet to be introduced. Switzerland ratified the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters in 2014. Since 2015 environmental information has had to be released in open and digital form (if possible), as part of an "open government data" system.

Federal "enforcement aids" promote uniform application of federal law across the cantons. However, there are no cantonal environmental inspectorates and a 2013 federal survey revealed that insufficient inspection was impeding proper implementation of environmental law. Switzerland needs to mobilise more inspection resources, prioritise risk-based inspection and develop inspection synergies among cantons (via methods such as peer reviews). Environment police exist in most cantons, but prosecutors often lack expertise in environmental law. Switzerland has strengthened liability rules for environmental damage; in particular, the law now requires the clean-up of contaminated sites.

Promising steps towards greener growth

Switzerland has made progress in greening its economy, as illustrated by its above-average performance on a number of green-growth-related indicators. It has opportunities to do more, including addressing the environmental impact of consumption. Acknowledging the need to further green the economy, the Federal Council (the government) adopted a well-defined Green Economy Action Plan in 2013. A major achievement of climate policy was the introduction, in 2008, of a CO_2 tax, which was raised to EUR 77 per tonne in 2016, one of the highest rates in the OECD. However, a narrow tax base (road fuel is excluded and there are many tax exemptions) combined with a low carbon price under the Swiss emission trading system makes it challenging to meet the intended GHG reduction objectives by 2030.

The planned phase-out of nuclear energy will require scaling and speeding up the deployment of renewable energy sources and energy efficiency solutions. Policy options include expanding the CO_2 tax base and incentive-based taxation more generally. Switzerland is one of the few OECD countries that tax diesel fuel at a higher rate than petrol. The heavy goods vehicle tax was effective in speeding up renewal of the fleet and the modal shift of freight from road to rail. However, mobility pricing has remained at the level of pilot testing. The economy features a sizeable financial industry. Mainstreaming environmental considerations into business and investment decisions, as well as increasing private participation in financing green investments, could yield significant environmental benefits.

Paving the way for new aspects of water management...

Switzerland is one of the first countries implementing a national policy to reduce micro-pollutants in municipal sewage treatment plant effluents, consistent with the polluter-pays principle. Many micro-pollutants have been detected in Swiss surface waters, and they can have adverse effects on aquatic ecosystems (e.g. feminisation of male fish by hormonally active substances) and possibly on human health. Nitrogen and pesticide loads in watercourses remain too high. Switzerland is considering tax incentives to improve agricultural nutrient and pesticide management but it lags behind the European Union in preparing a pesticide action plan. Growing urbanisation threatens groundwater, the source of 80% of Swiss drinking water, so groundwater protection should become an integral part of land use planning.

Switzerland has embarked on an innovative approach to the rehabilitation of its rivers. Around 40% of rivers have been altered, with adverse consequences for nature and landscape. Since 2011, the cantons must provide sufficient space for all surface waters to ensure their natural functioning; hydropower production must reduce its negative impact on downstream waters by 2030 and some 25% of waters with poor morphological status must be rehabilitated over the longer term. Switzerland is also to be commended for its consensus-building approach to setting "acceptable" minimum flows for hydropower development since 1991, though the approach has rarely been implemented in practice. About 25% of hydropower plants built prior to 1991 do not meet the pre-1991 minimum flow requirements, which were less stringent.

... but lagging behind in biodiversity conservation policy

Switzerland released a national biodiversity strategy in 2012 and finally approved the accompanying action plan in September 2017, three years past the commitment to do so. Protected areas have expanded but remain short of the global Aichi target to protect 17% of

the earth's land surface by 2020. Switzerland also has lower levels of strict protection than other OECD countries, relying heavily on a game reserve designation originally intended to limit excessive hunting. The quality of protected areas is also lacking: many are too small, poorly connected with each other and with European networks, and do not fully meet conservation objectives. Access to information on the state of biodiversity and proactive awareness campaigns are necessary to correct what polls show is a misconception by most Swiss that nature is doing well.

Efforts have been made to mainstream biodiversity considerations into sectoral policies, but more could be done. Significant reform to agricultural support has shifted emphasis to biodiversity and landscape protection. Switzerland has dedicated only 5.6% of forest surface as forest biodiversity reserves, among the lowest levels in Europe, though it committed itself to protect 8% by 2020 and 10% by 2030. Expansion of tourism and transport infrastructure increases the risk of landscape fragmentation and habitat disturbance. More wildlife corridors are needed, along with increased reliance on fees for tourism operations. Maintenance of landscape services is ultimately in the tourism industry's interest, so there is a good case for consumers of these services paying for their maintenance.

Assessment and recommendations

The Assessment and recommendations present the main findings of the Environmental Performance Review of Switzerland and identify 42 recommendations to help Switzerland make further progress towards its environmental policy objectives and international commitments. The OECD Working Party on Environmental Performance reviewed and approved the Assessment and recommendations at its meeting on 27 June 2017. Actions taken to implement selected recommendations from the 2007 Environmental Performance Review are summarised in the Annex.

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1. Environmental performance: Trends and recent developments

Switzerland has a small open economy, with the fourth highest gross domestic product (GDP) per capita in the OECD. Economic growth quickly recovered after the 2009 recession, faster than that of its main European trading partners, driven mainly by exports and household consumption. Living standards have continued to increase, with annual average growth of 0.6% over 2009-15 (OECD, 2017a). Rising income and consumption have resulted in higher waste generation and stronger pressures on the environment. This is particularly the case on the Swiss Plateau, whose population density is comparable to that of the Netherlands.

Switzerland is poorly endowed with mineral raw materials and energy resources other than water. Perhaps not surprisingly, it is a top OECD performer in terms of energy supply per unit of GDP, greenhouse gas (GHG) emissions per unit of GDP and GDP per unit of domestic material consumption. However, Switzerland remains among OECD countries with a relatively high per capita consumption-based environmental footprint, as was noted in the previous Environmental Performance Review (OECD, 2007). Further, between half and three-quarters of the Swiss environmental impact is estimated to be embodied in the import of goods and services, in particular in relation to food consumption, housing and mobility (Frischknecht et al., 2014). As a result, more sustainable patterns of consumption should be sought to further improve Switzerland's resource efficiency in the context of global value chains.

A mountainous country at the centre of the Alpine arc, Switzerland is known as the water tower of Europe for its significant water resources. It also has a rich variety of natural and cultural landscapes, which contribute to the reputation of Swiss tourism and, consequently, to economic development. The Swiss public perceives environmental quality as generally high (FSO, 2016). However, water quality is threatened by nutrient pollution from agriculture and by micro-pollutants, while economic development has profoundly altered the structure of watercourses. Biodiversity is challenged by land use intensification – for agriculture and construction of settlements, roads and industrial zones – and the landscape is increasingly fragmented by expanding infrastructure.

Climate change and energy mix and intensity

Over the past decade Switzerland has achieved the goal of decoupling economic growth from domestic GHG emissions (Figure 1), becoming the top OECD performer in terms of GHG emission intensity. The economy's low carbon intensity stems from high shares of renewable energy resources and nuclear energy in the energy mix and an economy dominated by services (Figure 1). Switzerland has no domestic production of crude oil or natural gas and the share of fossil fuels constitutes less than half of total primary energy supply (TPES), well below the OECD share of 84%. Coal provides a smaller share than in any other OECD country (less than 1%).

The May 2017 popular vote confirming a 2011 decision to gradually phase out nuclear energy necessitates a new energy strategy, including accelerated deployment of renewables,

aiming at a significantly higher share in final energy consumption by 2050. In 2015, Switzerland ranked in the first ten OECD countries in terms of renewables' contribution to TPES and in terms of electricity generated from renewable resources. While 60% of the renewable energy supply comes from hydropower, the contribution of all renewables has increased since 2000.

Switzerland was one of the OECD's best-performing countries in terms of energy used by the economy in 2015 (TPES per unit of GDP). Transport is the largest energy consumer, using a third of final energy and over half the fossil fuels in the overall energy supply. To decarbonise the sector, Switzerland aims for a modal shift from road to rail and for improved public transport.

Air quality

Overall, air quality has improved significantly yet not enough to protect people and ecosystems. With the decline in emissions since 2000, including fine particulate matter ($PM_{2.5}$) (Figure 1), all major air pollutants have been decoupled from economic growth. The main sources now are transport, wood combustion, agriculture and industry. All cantons have drawn up programmes of measures for air protection.

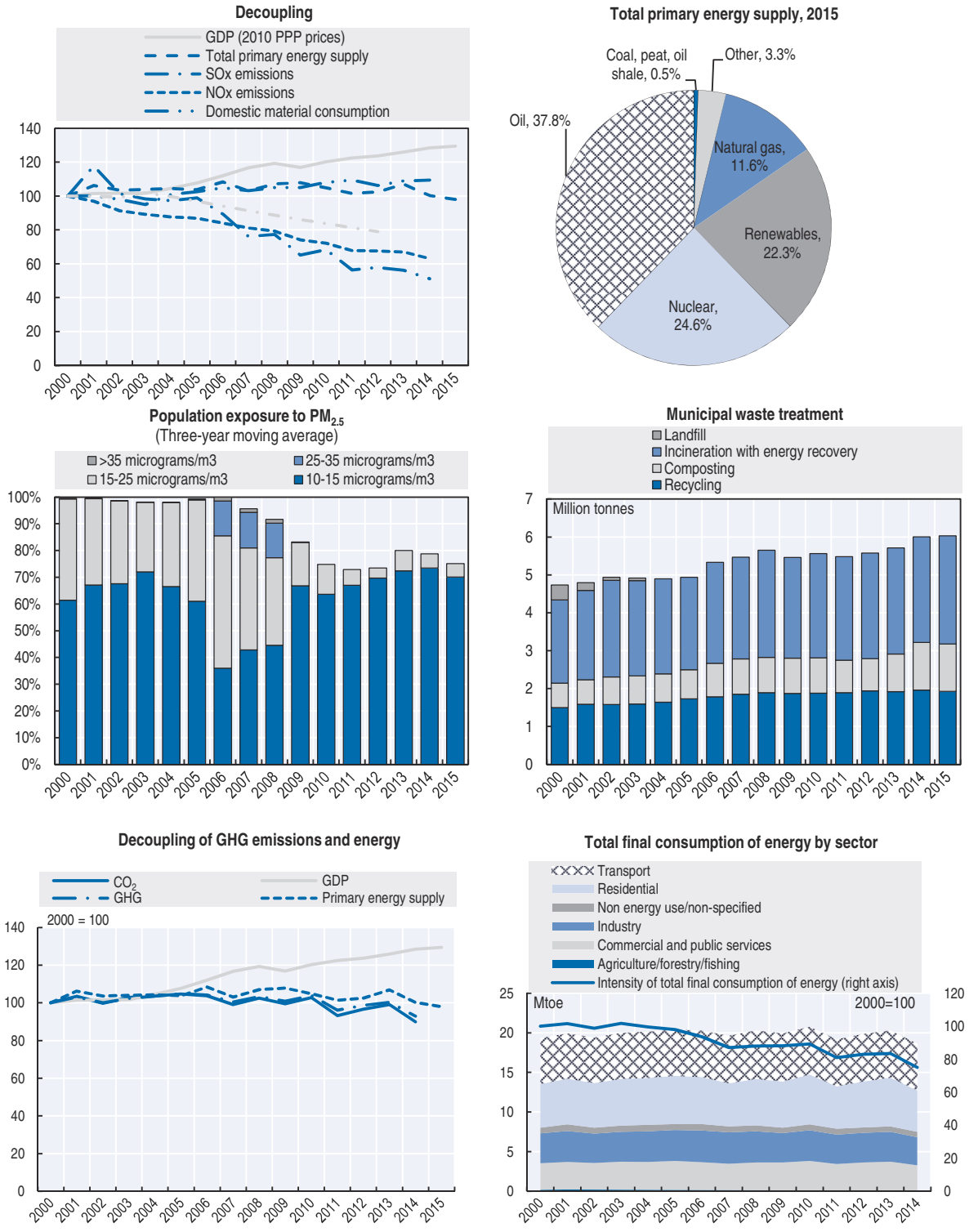
However, in areas of heavy traffic, levels of coarse particulate matter (PM_{10}) and nitrogen dioxide (NO_2) are still above the legal ambient limit values, as are summer ozone levels in rural areas of Ticino canton. Population exposure to $PM_{2.5}$ remains a source of concern (Figure 1). PM and ozone air pollution cause 2 000 to 3 000 premature deaths per year (Roy and Braathen, 2017). Related health costs are estimated at over USD 13.7 billion per year (2.7% of GDP in 2015), mostly from cardiovascular and respiratory diseases. In 2007, Switzerland decided not to renew its first National Environmental Health Action Plan (NEHAP), which had been implemented since 1998. Institutional co-operation between the Federal Office for the Environment (FOEN) and the Federal Office of Public Health has continued since 2007 (for example, in the areas of chemicals and sustainable development), but there is no holistic view of environmental health problems in Switzerland nor an assessment of the costs and benefits of public action in this area. This is unfortunate at a time when NEHAP is becoming increasingly important in other European countries.

There is ample evidence of the impact of nitrogen deposition on biodiversity (Chapter 5). Two-thirds of the nitrogen deposited originates from ammonia, 92% of which comes from agriculture. Switzerland should evaluate the cost-effectiveness of current measures aimed at reducing ammonia emissions from agriculture, which have not been fully successful. Although federal authorities have supported low-emission technology and placed considerable emphasis on low-emission design of barns and yards, ammonia emissions continue to far exceed the critical limit value and have not significantly declined over the past decade, much less met the 40% reduction (from 2005 levels) in the 2009 Federal Air Protection Strategy to address critical loads.

Waste management and circular economy

Switzerland has a very high level of municipal waste per capita – 742 kg in 2015, one of the largest amounts among OECD countries – and municipal waste generation has increased by 27% since 2000 (Figure 1), in line with private final consumption. While municipal waste management policies have been effective in encouraging recycling (Section 3), there is considerable room for improvement when it comes to reducing residual municipal waste. Since 2000, Switzerland has forbidden landfilling of combustible waste

Figure 1. **Selected environmental performance indicators**



Note: Total final energy consumption is expressed per unit of GDP in 2010 prices and purchasing power parities.
Source: OECD (2017b), *OECD Environment Statistics* (database); OECD (2016), *OECD National Accounts Statistics* (database); IEA (2017a), *CO2 Emissions from Fuel Combustion Statistics* (database), IEA (2017b), *IEA World Energy Statistics and Balances* (database); Eurostat (2016), *Material flow accounts* (database)

StatLink http://dx.doi.org/10.1787/888933571055

and of biodegradable municipal waste. Landfilling has been replaced with incineration and recycling, each of which covers around half of the municipal waste treated.

While waste recycling policies have turned out to be effective, there is still room for closing the loops and moving towards a circular economy. For example, besides excavation material, construction and demolition waste, at over 15 million tonnes per year, is by far the biggest waste stream. Hence the closure of material cycles and recycling clearly make sense in this sector, which so far has achieved 80% waste prevention and material recovery. Introducing extended producer responsibility requirements for construction materials, as in Germany, would create incentives to take end-of-life costs into account in product design (Watkins et al., 2012). Virgin-material taxes could also be considered to stimulate greater use of recycled substitutes; to that end, they should be confined to commodities where international trade is limited due to high transport costs relative to value (e.g. gravel, sand) (Smith, 2014). Another possibility would be to aim for a higher share of recycled materials in construction materials (the share is currently only around 10%).

Construction materials, such as gravel and sand, account for nearly 50% of Switzerland's domestic material consumption (DMC), the largest share in the OECD. In 2013, Swiss DMC productivity, defined as the amount of GDP generated per unit of DMC, was among the highest for any OECD country. Since 2000, however, DMC has increased by 9%, compared with an average decrease of 11% in the European Union (EU).

Water resource management

Switzerland ranks in the middle of the OECD in terms of freshwater resources per capita, and extracts a low share of its available freshwater resources compared to the OECD Europe average. Over the past decade, water abstractions as a share of available resources decreased by over a fifth, meaning reduced pressures on water resources. This is a welcome trend. However, land use intensification threatens the protection of groundwater abstraction areas.

Water quality has a mixed record. The construction of sewage treatment plants has considerably reduced phosphorus and nitrogen pollution in medium-sized and large rivers and lakes. However, micro-pollutants are a rising challenge and water quality in small rivers and aquifers continues to be threatened by diffuse agricultural pollution.

Minimum river flows have received particular attention in legislation, largely due to the importance of hydropower generation. In addition, the structure of watercourses has been profoundly altered over time to gain land for agriculture and building, provide protection against floods and install and operate hydropower plants (Section 4).

Protected areas and biodiversity

Over the last century Switzerland lost a significant part of previously widespread habitats such as alluvial zones, mires, and dry meadows and pastures. Expert assessments indicate that about half of the approximately 235 Swiss habitat types are classified as endangered (FOEN, 2017a).

In the late 2000s, as much as 79% of reptiles, 62% of amphibians, over a third each of mammals and birds, and over a quarter each of freshwater fish and vascular plants were classified as vulnerable, endangered or critically endangered. Pressures on biodiversity include intensive agriculture, the channelling and use of water bodies for generating electricity, soil sealing, landscape fragmentation and the spread of invasive alien species.

Although Switzerland adopted a biodiversity strategy in April 2012, development of the related action plan took longer than expected and it was finally released in September 2017.

Recent polling showed that a large majority of Swiss believe nature in Switzerland is doing very well (FOEN, 2017a). This misperception of the risks facing biodiversity may contribute to biodiversity protection being given low priority vis-à-vis economic development objectives (Section 5).

Recommendations on air, waste, environmental health and information

Air management

- Further reduce levels and deposition of acidifying, eutrophying and ground-level ozone air pollution below critical loads and levels as set out by the Convention on Long-range Transboundary Air Pollution; to that end, set more stringent emission reduction commitments for ammonia, ozone precursors (nitrogen oxides, volatile organic compounds and methane), sulphur oxides and fine particulate matter (e.g. following the example of EU Directive 2016/2284 for the period beyond 2020) and achieve them in accordance with the polluter-pays principle while ensuring coherence with existing instruments (e.g. instruments to reduce agricultural nitrogen surpluses, EURO standards for vehicles, VOC tax for solvents).
- Implement further measures to combat ground-level ozone in Ticino canton, including via more targeted and time-limited measures during the summer.

Waste management

- Prepare a federal waste prevention strategy including indicative targets for municipal waste reduction.
- Consider developing a national resource efficiency strategy to tackle the issue of high DMC levels; in particular, further improve recycling and material recovery of construction and demolition waste by assessing the cost-effectiveness of introducing measures such as extended producer responsibility requirements for construction materials similar to those in Germany, a tax on virgin materials extracted in Switzerland (e.g. gravel, sand) drawing on experiences in Sweden, Denmark and the United Kingdom, and a target for the use of recycled building materials.

Environmental health and information

- Consider developing a new NEHAP with a view to cost-effectively tackling remaining health effects of pollution.
- Strengthen efforts to raise public awareness and avoid public misperception of the state of the environment and of the risks facing Swiss ecosystems; to that end, develop public communication campaigns and foster environmental education at the federal and cantonal levels, and promote local awareness-raising approaches (e.g. as part of Local Agenda 21 and Agenda 2030 for Sustainable Development).

2. Environmental governance and management

EU environmental regulations do not directly apply to Switzerland, as the country is not a member of the EU or the European Economic Area, whose non-EU members have agreed to align their environmental legislation with the EU acquis. Switzerland is, however, a member of the European Free Trade Association and has established bilateral agreements with the EU in various areas, including agriculture, public procurement, and air and road

traffic. In that context, the country has integrated certain aspects of EU legislation into national legislation, while retaining its prerogatives on environmental policy.

Institutional framework

Switzerland needs to make more efforts to strengthen vertical co-ordination between the Confederation and the cantons. While progress has been made since the *2007 OECD Environmental Performance Review* (EPR), a 2013 study commissioned by FOEN revealed that environmental law was not uniformly applied countrywide. Cantons participate in the Conference of Heads of Services for Environmental Protection and similar thematic networks, although they are not involved in all working groups. There are no formal networks for all environmental sectors. FOEN's "enforcement aids", guidelines for cantons to harmonise environmental law, are not always comprehensive or systematically updated (FOEN, 2013a; CCE, 2016).

Regulatory framework

Switzerland lacks strategic environmental assessment (SEA) of plans and programmes. Recent attempts by the government to introduce efficiency evaluation into spatial planning, including elements of SEA, has not yet translated into regulatory reform. Switzerland has a well-developed and effective system of *ex ante* environmental evaluations. These include regulatory impact analysis to examine the economic and social impact of draft laws, and other types of assessment dedicated to sustainability and the environment, such as the sustainability assessment carried out by the Federal Office for Spatial Development and the economic assessment of environmental legislation, which FOEN carries out. FOEN should ensure consistency among these various procedures (FOEN, 2016a; SECO, 2016).

As the 2007 EPR noted, Switzerland's approach to permitting is in contrast with the EU-wide practice of integrated pollution prevention and control for high-risk installations. In most cantons, environmental conditions are prescribed in operating and building permits, which cover some environment-related aspects, such as air, water, waste and noise. There are differences across cantons in the scope and stringency of environmental requirements included in permits. Introducing integrated permits for facilities with a high potential environmental impact and simplified requirements (e.g. general binding rules) for low-risk ones could decrease the administrative burden on the regulated community and favour a holistic approach to pollution prevention (Mazur, 2011).

Compliance assurance

The institutional framework for compliance assurance remains highly fragmented. Cantons are in charge of ensuring compliance with environmental regulations and have discretion in the means of achieving it, which leads to significant discrepancies among cantons. Inspections are not integrated across environmental media, except in some cantons where site visits may be conducted jointly by inspectors responsible for different environmental issues.

The Environmental Protection Act (EPA) provides for administrative injunctions and orders of corrective action in response to non-compliance. It also stipulates criminal sanctions for serious offences, which are low compared to other OECD countries. Cantons can impose administrative fines, but the definition of the violation and amount of fine for a given offence can vary widely by jurisdiction. Environmental police exist in most cantons and can initiate prosecution, as can public prosecutors. However, the latter generally lack

awareness and technical expertise on environmental matters, weakening criminal environmental enforcement (Petitpierre, 2015).

Switzerland has about 38 000 contaminated sites, of which 15 000 need investigation to assess their environmental status. It is estimated that 4 000 need remediation. Remediation of severely contaminated sites (e.g. hazardous waste landfills) was completed in 2017. Operators are required to deposit a financial guarantee that would cover potential investigation and remediation costs. In accordance with the 2008 Ordinance on the Charge for the Remediation of Contaminated Sites, Switzerland has a financing mechanism for remediation of contaminated sites. It consists of a special fund, financed by a charge on landfilled waste, that provides cantons and municipalities with partial repayment (40%) of remediation costs. Switzerland has strict (no-fault) liability for environmental damage. The EPA mandates remediation of contaminated sites and their inventory in publicly available cantonal registers. However, it does not specify environmental damage to any element of the environment.

Voluntary agreements to achieve environmental goals are widely used. In the energy sector they are carried out through specialised agencies that help enterprises meet cantonal targets on energy efficiency. For example, the Swiss Association of Waste Treatment Facility Operators aims at reducing CO_2 emissions from waste incineration among its members and increasing plant efficiency in exchange for exemption from the national emission trading system (ETS).

There is substantial room to strengthen green public procurement, an area currently lacking a policy framework and targets. Promotion of green practices through guidance documents and advice is not systematically applied at the federal level. More should also be done by cantons to promote compliance with environmental law, which reduces social and regulatory costs, especially among small and medium-sized enterprises (SMEs) (OECD, 2015a).

Environmental democracy

Switzerland has a long tradition of enabling citizens to express their concern about environmental issues through referendums and popular initiatives. These instruments of direct democracy are useful in engaging the public in environmental debates and giving an impulse to the government's policy making. In a referendum on 21 May 2017, Swiss voters approved amendments to the Energy Act that pave the way for the gradual phase-out of nuclear energy, reduced energy consumption and increased reliance on local renewable energy sources. However, out of some 20 referendums that have been held since 2000 in relation to environmental issues, only 6 were approved.

Over the last decade, significant progress has been made in including sustainability issues in education curricula. Education21, a recently established national centre for sustainable development education, provides pedagogical and financial support to teachers and institutions (Education21, 2016).

The government has improved public access to environmental information. As recommended in the 2007 EPR, Switzerland ratified the United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention). After ratification, the EPA was amended to define the type of environmental information that federal and cantonal authorities must provide to the public. The state of the environment is

assessed every four years in a report adopted by the Federal Council (the Swiss government). Access to justice is ensured through a right to appeal any federal or cantonal decision; appeals can be brought by anyone directly affected by such a decision.

Recommendations on environmental governance and management

Vertical co-ordination

- Harmonise and strengthen environmental policy and law implementation across cantons by improving vertical co-ordination, promoting regular performance monitoring mechanisms and indicators; continue to disseminate best regulatory practices across cantons.

Regulatory framework

- Consider introducing integrated environmental permits for large industrial installations, based on best available techniques, to move towards a holistic approach to pollution prevention; simplify the regulatory regime for low-risk installations by introducing sector-specific general binding rules.
- Introduce requirements for SEA of plans and programmes; ratify the UNECE protocol on SEA.

Compliance assurance and promotion

- Improve the effectiveness and efficiency of compliance monitoring by strengthening risk-based inspection planning and developing guidelines for specialised inspection services; promote integrated inspections across environmental media.
- Develop federal guidance to cantons on the use of enforcement tools; strengthen sanctions for non-compliance with federal environmental regulations; consider introducing prosecutors specialised in environment or provide environmental training to public prosecutors to facilitate criminal enforcement.
- Improve the system of liability by defining damage to specific environmental media.
- Encourage voluntary compliance and diffusion of green practices among enterprises by providing sector-specific guidance, especially to SMEs, and offering incentives for environmental management system certification; strengthen green public procurement by setting targets and monitoring their achievement.

3. Towards green growth

Switzerland has made progress in greening its economy, as illustrated by its above-average performance on some green-growth-related indicators, but it has opportunities to do more. These include, in particular, shifting to a coherent green tax system to address consumption-related environmental effects, greening public procurement as well as the investment practices of its prominent corporate and financial sector, fostering eco-innovation, and aligning its trade and environmental policies.

Green economy framework and overall performance

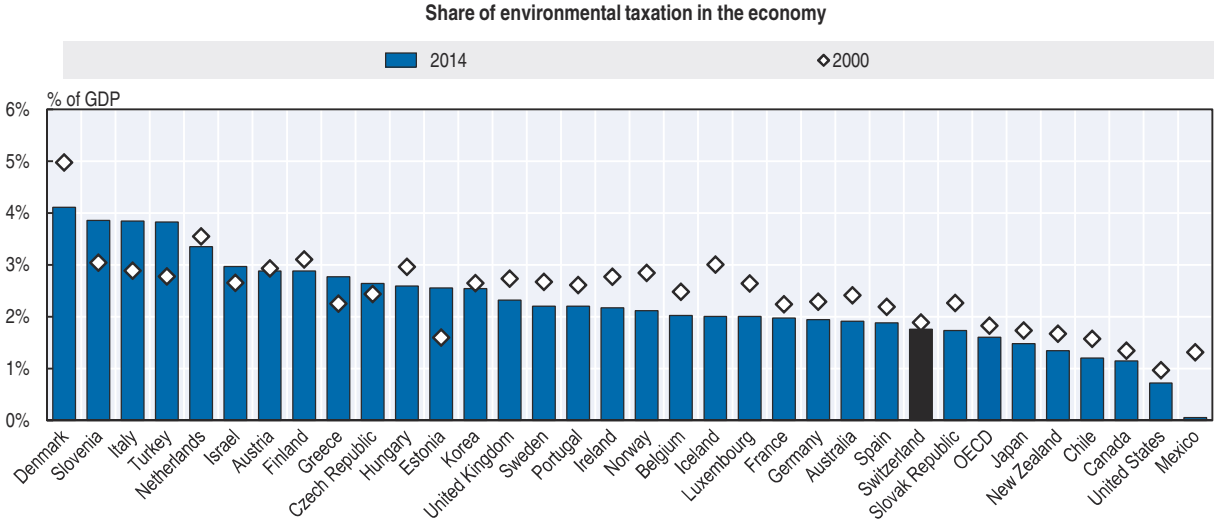
Acknowledging the need to further green the economy, the Federal Council adopted a well-defined Green Economy Action Plan (GEAP) in 2013; its 2016-19 variant remains the centrepiece of the green economy strategy. It is focused on three priority areas: consumption and production, waste and raw materials, and cross-cutting instruments. While the GEAP considers that existing policies (e.g. on energy, climate, spatial planning) already help

reduce the economy's environmental impact, its links with other strategic policy processes, such as Energy Strategy 2050 and the four-year Agriculture Policy packages, could be clarified. Successive votes by the parliament (2015) and general public (2016) turned down more extensive and binding green economy measures, which were perceived as too radical and potentially harmful to the economy. The incremental, step-by-step approach favoured by authorities, the business sector and voters alike might prevent more ambitious and transformational commitments.

Greening the tax and incentive systems

Accrued total tax revenue is equivalent to 27% of GDP, a percentage that has remained stable and is significantly lower than in neighbouring European countries. Accrued environmentally related tax (ERT) revenue was equivalent to 1.8% of GDP in 2014 (the percentage was stable over the review period), slightly higher than the OECD average (Figure 2) but below the OECD Europe average (2.5%). Unlike in most OECD countries, where energy typically dominates ERT, the share of transport-related revenue rose steadily to nearly half. The 2007 EPR recommendation to implement green tax reform was envisioned by the first Sustainable Development Strategy in 2002, but Switzerland appears to face political difficulties when it comes to carrying out such reform at scale. For instance, a range of environmentally harmful subsidies and tax exemptions remain in place. Nevertheless, some ERTs and fees have proved at least partly effective.

Figure 2. **Environmentally related taxation is low and decreasing**



Source: OECD (2017c), OECD Database on Instruments Used for Environmental Policies and Natural Resources Management (database).

StatLink http://dx.doi.org/10.1787/888933571074

A major achievement is the 2008 introduction and increase of a CO_2 tax on heating- and process-related fossil fuels, which was CHF 84 per tonne (about EUR 77) as of January 2016. While this positions Switzerland among front runners in terms of tax rate, the tax base does not cover road fuels. Instead of planning a gradual increase in the tax rate, as the EU advocates, future increases would depend on the evolution of CO_2 emissions. Companies liable for the tax may be exempted if they voluntarily commit to uninterrupted emission reductions by 2020, but eligibility criteria are lax, as applicants propose targets themselves

based on "economically viable reduction potential". In parallel to the CO_2 tax, Switzerland set up its ETS, but as of 2016 it only covered 55 companies accounting for 11% of national emissions. Furthermore, while the price of CO_2 emission allowances was as high as CHF 40.25 per tonne in May 2014, a regulation brought it down to CHF 6.5 in March 2016, much closer to the price in the EU ETS.

Over 2008-13, some 2.5 million to 5.4 million tonnes of GHG reduction was achieved, which represents only 1% to 2% of the emissions Switzerland reported under the United Nations Framework Convention on Climate Change over the period (FOEN, 2016b). The CO_2 Act sets a 20% domestic GHG target by 2020 and Switzerland has submitted a well-defined Intended Nationally Determined Contribution setting a GHG reduction target of 50% by 2030. Despite the relatively strong price signal provided by the CO_2 tax, the combination of a low carbon price under the Swiss ETS (potentially worsened by the expected link with the EU ETS) and the ease of benefiting from CO_2 tax exemption make reaching these objectives challenging. The heavy reliance of the 2030 indicative target on international offsetting leaves the door open to relatively modest domestic efforts.

In 2011, after the Fukushima accident, the parliament undertook to reform Swiss energy policy and asked the Federal Council to prepare an energy strategy to foster a shift from nuclear power to renewables by 2050. In 2013 the government submitted a first package of Energy Strategy 2050 measures. On 30 September 2016, the parliament prepared the necessary amendments to the Energy Act, which were approved by referendum on 21 May 2017 (Section 1). The first package, covering 2018-20, provides financial support, via levies on electricity bills, to cover part of the cost of investment in renewables. Electricity consumers also subsidise renewables development via market premium and market price support (feed-in tariffs). This means electricity consumers will assume the cost of the energy transition. The Energy Act underwent a referendum because the policy involves a differentiated financial effort between households, small and medium-sized enterprises (SMEs) and large firms to support the energy transition. The case of a CHF 00.023/kWh supplement on electricity bills paid exclusively by households and SMEs (and reimbursed to large firms) is an illustration of this.

Looking ahead to 2021 and the second stage of Energy Strategy 2050, the government has begun to explore options for shifting the basis of the energy transition policy from support by electricity consumers to tax incentives related to energy and climate. On 28 October 2015, the Federal Council sent the parliament a draft of the required constitutional amendment for consideration. However, the National Council (lower house) decided on 8 March 2017 not to examine the proposal. Similarly, the Council of States (upper house) rejected it in June 2017. Switzerland should consider ways to expand the CO_2 tax base and address misalignments between climate change objectives and policies in the areas of investment, taxation, innovation, urban mobility and forestry, to name a few.

A long-standing area of concern relates to freight transport through the Alps. To reduce the associated environmental impact, in 2001 Switzerland introduced a distance- and weight-based tax on goods vehicles above 3.5 tonnes. The tax provides a better incentive to reduce air pollutant emissions than the Eurovignette in Belgium, Denmark, Luxembourg, the Netherlands and Sweden, which is not distance-based and applies only to goods vehicles above 12 tonnes. The Swiss tax further differentiates rates to provide incentives to meet more recent and stringent EURO emission standards and undertake diesel particle filter retrofits. Such differentiation has been effective in leading to renewal and upgrade of the

heavy goods vehicle fleet (FOT, 2016). The tax also contributed to progress in the modal shift of freight from road to rail. But Switzerland remains far from reaching its goal of a maximum of 650 000 trucks crossing the Swiss Alps per year by 2018. Despite a 30% reduction over 2000-14, 1 million heavy goods vehicles travelled through the Alpine region in 2015 (FOT, 2016). With the December 2016 opening of the Gotthard Base Tunnel, the world's longest rail tunnel, the share of freight travelling by train is expected to rise further. However, meeting the 2018 target also depends on efforts to shift freight from road to rail in other countries. For instance, France and Austria have achieved much lower shares of rail in their transalpine freight transport.

As regards road fuel taxation, Switzerland is one of the few OECD countries that tax diesel fuel at a higher rate than petrol, which makes environmental sense given diesel's higher carbon and air pollutant emissions. However, the 2007 EPR recommendation to increase the tax levels for both fuels so as to further improve pricing of environmental externalities has not been met. A possible extension of the CO_2 tax base to include road fuels, which falls within the scope of the CO_2 Act, was considered but a parliamentary consultation led to its abandonment because of public opposition. Switzerland imposes a penalty on imports of cars that do not comply with a per-kilometre target for CO_2 emissions, however.

Switzerland has been pilot testing mobility pricing, as mandated by the Federal Council in its 2011-15 term. Consultations conducted in 2015 revealed that the majority of cantons and civil society are favourable to the principle of mobility pricing, which could include incentives to travel outside the peak traffic hours and be differentiated based on vehicle emission standards.

As Switzerland does not produce crude fossil fuels, its support to fossil fuels only concerns industrial and final consumption (OECD, 2015b; OECD, 2013). The annual support was estimated at CHF 260 million in 2014, exclusively in the form of tax expenditure (refunds and exemptions). This places Switzerland among OECD countries with a relatively low ratio of tax exemptions for fossil fuel consumption to total tax revenue (0.1%, compared to the OECD average of 0.4%). Even so, removing such exemptions would free resources that could allow the current public support to renewables development to double. Furthermore, a noticeable trend in fossil fuel subsidies is the growing share represented by CO_2 tax exemptions, a consequence of the gradual increase of the tax rate.

The level of agricultural policy support remains among the highest in the OECD in terms of transfers from consumers and taxpayers as a share of gross farm receipts. However, Switzerland has pursued the significant agricultural policy reforms initiated in the mid-1990s, in particular by redirecting budgetary support from production to the provision of environmental services. The proportion of payments with explicit environmental objectives increased from 6% in 2000 to 23% in 2015. In particular, under Agriculture Policy 2014-17, the payments increasingly focus on preserving agricultural landscape and biodiversity. Another important policy change was replacing headage payments with grassland area payments for dairy cows. The former had encouraged intensification of livestock farming, although the latter is conditional on minimal stocking density. Under Agriculture Policy 2014-17, direct payments continue to be subject to environmental cross-compliance (i.e. farmers must show proof of ecological performance to be eligible). However, enhancing cost-effectiveness of payments would require targeting them to local ecological conditions and restricting them to provision of well-identified and otherwise unremunerated public goods and services. This is

not the case with environmental cross-compliance, which only acts as a threat for non-compliance with environmental regulations regardless of local conditions.

Together with continuously increasing volumes of road transport, municipal solid waste (MSW) illustrates Switzerland's difficulties in reducing the environmental impact of consumption. A pay-as-you-throw system involving a fee per bag used, also called a bin-liner fee, was introduced in 1997 and is now in place in 90% of municipalities. Under the EPA (Article 32a), the fee pursues the goal of full cost recovery (i.e. fees should cover all MSW disposal costs, including capital depreciation). Waste-stream-specific fees (e.g. for beverage containers, batteries) and extended producer responsibility programmes (for electrical and electronic equipment) are also in place. This mix of instruments, combined with the prohibition on landfilling combustible waste, has significantly increased MSW recycling rates. However, it has prevented neither a renewed heavy reliance on incineration nor a continuous increase in MSW generation per capita, which remains significantly above the OECD average.

Public investment in support of a greener economy

Government environmental protection expenditure (EPE) slightly increased over the review period to CHF 4.3 billion in 2014 or around 0.7% of GDP, in line with the EU average. The rise in EPE on air and climate may reflect increased efforts to curb CO_2 emissions following introduction of the CO_2 tax in 2008. The steady decrease of EPE on sewage since 2000 reflects the decreasing investment need for sewage treatment plants, as they are already equipped with tertiary treatment, although upgrades to better treat micro-pollutants have begun. More generally, the government expects an increase in EPE as well as broader environmental expenditure due to ageing infrastructure, population growth and urbanisation (including urban sprawl). This raises the question of how to meet financing needs without increasing the government debt/GDP ratio.

Looking at the greening of infrastructure investment beyond traditional environmental protection and infrastructure, Switzerland has taken notable policy steps regarding renewables, energy efficiency in buildings and sustainable transport. Indeed, the planned nuclear phase-out requires identifying and implementing cost-effective renewables capacity and energy efficiency improvement at scale to avoid an increase in the GHG intensity and import dependence of the energy mix. When making such investments, potential environmental effects should be taken into account, particularly in protected natural areas.

In terms of new renewables capacity (in addition to further reliance on hydropower), however, Switzerland appears to have voluntarily aimed at slow deployment. While the feed-in tariffs (FITs) introduced in 2009 reached their initial goal of triggering development of new renewables-based power capacity (Fondation RPC, 2016), by 2014 only 3% of the electricity produced benefited from FITs (OECD, 2015c). Faster deployment is needed if Switzerland is to meet its climate goals while phasing out nuclear energy. The introduction of a one-off investment grant (as an alternative to FITs), and reduction of the FIT level and payment period (from 20 to 15 years) for renewables-based energy projects, however, underlines the will to avoid windfall profits and the cost burden of excessive long-term payment commitments. As of 2018, under the first package of measures of Energy Strategy 2050, Switzerland will replace the existing FITs with private contracts (contracts for difference) and introduce additional investment grants, thereby moving to solutions that are even more responsive to changing market conditions.

Turning to energy efficiency in buildings, Switzerland launched a joint federal-cantonal programme for energy efficiency in buildings in 2010. The subsidies for refurbishment achieved their reduction target, but the cantonal programme fostering the use of renewables and waste heat underachieved due to difficulties in mobilising matching funds. Nevertheless, the programme's cost-effectiveness (estimated at CHF 65 per tonne of CO_2 avoided after four years) exceeded expectations (Federal Council, 2016). In the context of Energy Strategy 2050, the parliament prolonged the programme beyond 2019 and increased the maximum amount earmarked for it to CHF 450 million per year, lowering the cantonal share and thus potentially addressing part of the cantonal funding shortfall. For both the buildings programme and support to renewables, reliance on earmarking (of the CO_2 tax and the grid tax, respectively) poses financial sustainability and redistribution issues.

Mobilising the corporate and financial sectors

The Swiss economy features large companies and a sizeable financial industry. Taking further steps to promote mainstreaming of environmental considerations into business and investment decisions, as well as to mobilise private participation in green investment, could yield significant environmental benefits domestically and internationally. Switzerland is proactively engaged in multiple international voluntary initiatives, in particular towards promoting ideas and options for making financial systems more sustainable (e.g. G20 Green Finance Study Group, Financial Stability Board Task Force on Climate-related Financial Disclosures). Domestically, it has established a dialogue with the financial sector to promote integration of environmental criteria in financing and investment decisions of players in the Swiss financial market.

Despites these initiatives, a FOEN-commissioned study (South Pole Group, 2015) estimated that the asset holdings of the Swiss equity fund market contribute to a global temperature increase scenario of between 2°C and 4°C above the Paris Agreement 2°C target. More generally, the share of assets managed according to environmental criteria remains negligible despite growth in recent years (Swiss Sustainable Finance, 2016), necessitating more ambitious goals and prompt action. Transparency and reliability of information on the environmental performance of business and financial sector investment are essential for consumers and market participants. More concrete actions in this area should be taken in the short term, both domestically and internationally, beyond reliance solely on voluntary approaches.

Fostering eco-innovation

Switzerland has continued to strengthen its overall international competitive advantage in science, technology and innovation, based on proactive and collaborative policies (OECD, 2014). This includes well-defined master plans for environment and energy research with themes of direct relevance to the GEAP, as well as efficient co-operation with the private sector fostered through voluntary economic-environmental collaboration. This has resulted in particularly high levels of process-related eco-efficiency improvements and demand for eco-innovation in the business sector. These elements support Switzerland's above-average production-based energy, GHG and material productivity, but are only partially captured by patent counts and narrow sectoral definitions of eco-innovation.

Nevertheless, Switzerland ranks low among OECD countries in the share of environment-related activities in its overall government research and development (R&D) budget (OECD,

2017d). Moreover, the share of environment-related patents has been lower than the OECD and OECD Europe averages since the mid-1990s (OECD, 2017e). Both trends could be explained in part by a policy shift towards non-thematic research, to which Switzerland devotes the highest public financial support in the OECD. However, there appears to be a specific funding gap on eco-innovation in the pre-commercialisation and demonstration phase due to a combination of limited public support beyond the prototype phase and a relative absence of domestic private-sector industrial champions. Switzerland holds a better relative position in the pharmaceutical and biotechnology industries in terms of both public R&D investment and patent-related revealed technology advantage (OECD, 2014). By maintaining a policy focus on short-term competitiveness, exempting GHG-intensive SMEs from the CO_2 tax increases the risk of them lagging behind in terms of low-carbon innovation and performance in the longer term.

Mainstreaming the environment in development co-operation and trade practices

Net official development assistance (ODA) has more than tripled at current prices since 2000, enabling Switzerland to meet the parliament's 2011 goal of reaching 0.5% of GNI by 2015, although this remains below the United Nations target of 0.7%. An increasing share of bilateral ODA addresses global and local environmental objectives (in particular climate change adaptation), probably at least in part due to the establishment of a common platform on international financing and development co-operation by the Swiss Agency for Development and Co-operation, the State Secretariat for Economic Affairs (SECO) and FOEN. Switzerland intends to enhance the mobilisation of its prominent private sector in support of international development and climate action, but has not yet laid out a clear strategy and concrete action plan to do so.

Ensuring coherence between trade and environmental policies is of utmost importance given the reliance of the economy on imports and exports. Since 2014, Switzerland has been one of the 17 World Trade Organization members negotiating an environmental goods agreement. In addition, the 2013 GEAP assigned SECO, in consultation with FOEN, the task of evaluating the environmental impact of free trade agreements (FOEN, 2013b). However, no free trade agreement has been subject to evaluation, even though opportunities to do so arose. Furthermore, SECO intends to decide whether to undertake evaluations case by case (Swiss Confederation, 2016). Such evaluations should be done much more systematically, especially given the particularly high share represented by imports in the environmental impact of final domestic demand.

Recommendations on green growth

Green economy framework

- Further strengthen inter-office collaboration to promote GEAP as a whole-of-government approach; foster coherence of GEAP with relevant plans and strategies, e.g. Energy Strategy 2050, Action for Corporate Social Responsibility, Sustainable Development Strategy.

Greening the tax and incentive systems

- Consider ways to widen the CO_2 tax base and strengthen efforts to align sectoral and macroeconomic policies for a low-carbon economy; this should include the phasing out of remaining tax exemptions and rebates for fossil fuel consumption, including to free budgetary resources for further developing renewables and improving energy efficiency.

Recommendations on green growth *(cont.)*

- Expand incentive-based taxation to reduce the environmental impact of consumption; in particular, consider introducing mobility pricing and making the bin-liner fee an incentive-based instrument rather than one aimed at recovering the costs of MSW disposal.
- Pursue efforts to make direct payments to farmers linked to the provision of well-identified and otherwise unremunerated public goods and services as a means of contributing to absolute decoupling between agricultural production and the environmental performance of agriculture.

Public investment in support of a greener economy

- Maintain or strengthen the polluter-pays principle to finance needed investment (e.g. in sewage treatment plants) due to ageing of environmental infrastructure, population growth and urbanisation, via an increase in corresponding charges, as necessary to ensure cost recovery.
- Further adjust the conditions for benefiting from support to changing market conditions in order to optimise the cost of the transition from nuclear power to renewables; for instance, applicants could be required to demonstrate that their investment would not be made in the absence of support.
- Ensure that earmarking of ERT revenue is bound to defined objectives and periods; the reliance of support to renewables and the energy efficiency in buildings programme on earmarking (of the grid tax and CO_2 tax, respectively) should, for instance, be reduced over time in order to increase flexibility of tax revenue allocation based on changing market conditions and spending needs.

Mobilising the corporate and financial sectors

- Take concrete steps to more systematically monitor, and create incentives for improvement in, the environmental performance of investments made by the financial sector; exclusion of environmentally harmful (e.g. fossil-fuel-related) activities from asset holdings and mandatory disclosure regarding the alignment of financial flows with international climate agreements could initially be implemented and tested with publicly owned entities, then progressively rolled out, which could significantly speed the sensitisation of the financial sector, leading to behaviour change at scale.
- Public-private partnerships between federal or subnational authorities and the financial sector could be further explored to mobilise private finance for greener infrastructure investment in renewables, energy efficiency and sustainable transport.

Fostering eco-innovation

- Take better advantage of Switzerland's world-leading strengths in research and innovation to reposition the country as a front runner in eco-innovation; concrete steps could include rejuvenating public support for eco-innovation, especially in the demonstration and early commercialisation phases, for which the well-working Swiss venture capital market could be better utilised.

Mainstreaming environment in development co-operation and trade

- Maintain, and consider strengthening, the common platform on international financing and development co-operation regarding the environment as a key enabler for Switzerland to meet its international ODA-, climate- and biodiversity-related financial commitments.
- Make evaluation of the environmental impact of any new trade agreement a requirement rather than relying on ad-hoc considerations; the yet-to-be-negotiated free trade agreement between MERCOSUR and the European Free Trade Association (which includes Switzerland) provides an opportunity to do so; in addition, consider options for greening the Swiss export credit agency's portfolio.

4. Water management

Status, trends and pressures

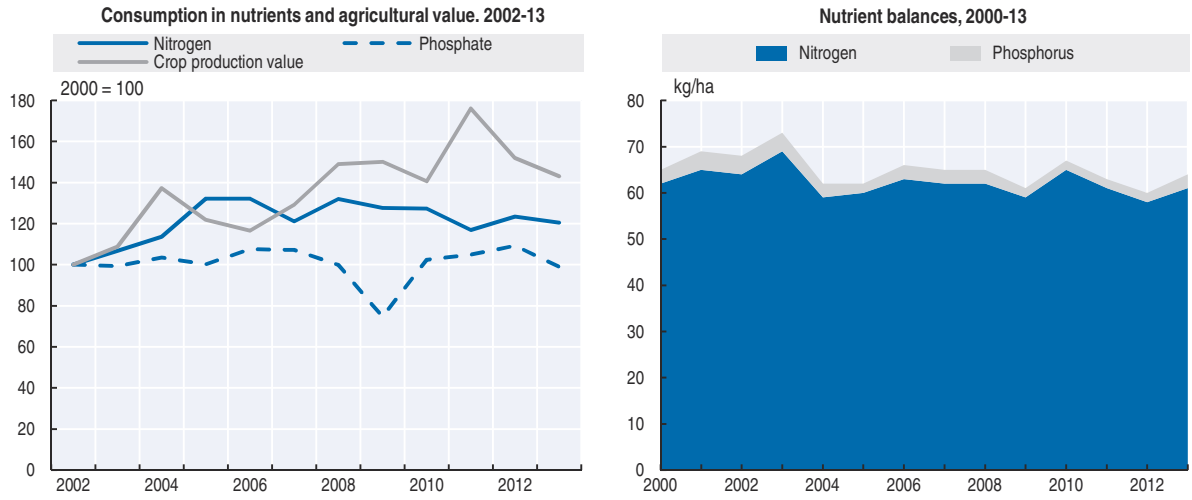
A large number of micro-pollutants have been detected in Swiss surface waters. In many medium-sized and large watercourses, their main source is urban sewage. A special observation campaign in 2015 revealed that many small rivers carried pesticides from diffuse sources, regularly causing ecotoxicological quality criteria to be exceeded. Even at very low concentrations, micro-pollutants can have adverse effects on aquatic ecosystems (e.g. feminisation of male fish by hormonally active substances) and possibly on human health. Measured levels of micro-pollutants in Swiss drinking water do not currently indicate unacceptable risk to the population (Gälli et al., 2009). However, over 30 000 potential micro-pollutants are in daily use in industrial, commercial and domestic applications as ingredients in plant protection products, biocides, pharmaceuticals and consumer goods such as body care and cleaning products. In 2006, FOEN initiated a survey of micro-pollutants in watercourses, focusing on substances in urban sewage. But there has as yet been no systematic overview of the quantities, uses, emissions, behaviour in the environment and toxicity of these substances, whose number and use are likely to rise due to increases in population and life expectancy (Gälli et al., 2009).

The National Surface Water Quality Monitoring Network (NAWA) reveals a mixed picture of the state of Swiss watercourses (FOEN, 2017b). Nutrient loads have been reduced overall but remain too high at almost 10% of NAWA stations; the share would be much higher if NAWA covered more small rivers, which account for about 75% of the Swiss river system and are particularly exposed to agricultural pollution. Rivers' ability to preserve aquatic biodiversity (invertebrates, aquatic plants) is insufficient for at least 40% of NAWA stations, and only a quarter of stations have sufficient water quality for fish. Moreover, despite efforts to remove phosphorus from sewage, half the 20 largest Swiss lakes still suffer from eutrophication and lack of oxygen, some of them to the point of having to be artificially ventilated. Lakes in areas of intensive farming are particularly affected. A national overview of the several thousand small lakes has not yet been done despite their importance for biodiversity. Some 60% of national groundwater monitoring stations on open land, where intensive agriculture prevails, have nitrate concentrations above 25 mg/litre.

Sewage treatment has reached a very high level: 97.3% of the population is connected to a sewage treatment plant, second only to the Netherlands in the OECD. The proportion of plants achieving tertiary treatment (nutrient removal) increased over the review period to 70% of sewage treated. However, the national nitrogen balance, calculated using OECD methodology, has been relatively unchanged since 2000 (Figure 3). At around 60 kg/ha of agricultural land, the Swiss nitrogen surplus is relatively high by OECD standards.

Around 40% of Swiss rivers (50% of those below 600 metres) are significantly modified as a result of intensified land use, leading to profoundly altered watercourses with consequences for ecosystem functioning. Over time, land use intensification has profoundly altered the structure of watercourses for long stretches. Many streams and rivers have been developed or altered to meet increasing land requirements or to protect populated areas from flooding. As a result, the space for watercourses has narrowed in many places, sometimes to only a drainage channel. In addition, a high degree of fragmentation by artificial structures affects the passage of migratory fish, changes the natural habitat distribution within rivers and modifies their ecological capacity. More than 100 000 artificial obstacles over 50 cm high hinder the free upstream and downstream movement of fish. Hydropower production also

Figure 3. **Agricultural nitrogen remains a source of concern**



Note: Nutrient balances and consumption are expressed in kilograms per hectare of agricultural area. Crop production value is expressed in USD at 2010 prices and purchasing power parities.
Source: FAO (2017), *FAOSTAT* (database); OECD (2017), "Agri-environmental indicators: nutrients", *OECD Agriculture Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571093

influences river flows and causes structural changes in waters. For example, when producing peak energy, storage plants cause sudden artificial variations in flow (hydropeaking) in downstream waters. The numerous structures designed to provide protection against floods, produce energy and gain land for agriculture or building have resulted in a quarter of the total length of Swiss rivers (15 000 km out of 60 000 km) having poor ecological structure. Moreover, growing urbanisation threatens protection zones around groundwater abstraction areas intended for drinking water supply, which sometimes requires the closure of drinking water supply stations or prevents the creation of new stations.

Strategic framework

While initiating the monitoring of micro-pollutants in water and their ecotoxicological impact, Switzerland decided to apply the precautionary principle and start reducing micro-pollutant discharges into water bodies. It is one of the first countries implementing a national policy to reduce micro-pollutants in municipal sewage treatment plant effluents. As conventional plants are not equipped to treat micro-pollutants, in 2016 Switzerland began equipping 120 plants to remove them. In this, it is also a front runner. Plant selection has been based on the risk of micro-pollutant discharge into the sea (an upstream responsibility), into rivers with low dilution capacity and into water bodies feeding drinking water reservoirs. This policy should lead to halving urban micro-pollutant discharges to rivers by 2040. Switzerland also plans to halve the risk to soil fertility, water quality and terrestrial and aquatic life associated with plant protection product toxicity within ten years following the adoption of a plant protection product action plan. Such a plan is being prepared; this is an area where Switzerland lags behind the European Union (Directive 2009/128/EC required EU countries to draw up pesticide action plans by 2012).

Another major strategic goal of water policy, triggered by a popular initiative, is to rehabilitate the natural functioning of surface waters (rivers, streams and lakes), which is a long-term endeavour. To this end, three amendments were made in 2011 to the Waters Protection Act (WPA). First, it became mandatory for the cantons to provide sufficient space

for all surface waters to ensure their natural functioning, including flood control. The space reserved for water can at most be farmed in a way that promotes biodiversity. Second, a national target was set to rehabilitate about 25% of waters with poor morphological status in the next 80 years, i.e. some 4 000 km of river length by about 2090. Third, Switzerland decided all its installations related to hydropower use must reduce their negative impact on watercourses (hydropeaking, changes in sediment transport and obstacles to fish migration) by 2030.

Enforcing protection of groundwater abstraction areas is another major challenge. Some 80% of drinking water originates from groundwater. For several years, Switzerland has worked to protect groundwater with land use planning measures. However, protection of abstraction areas is proving increasingly difficult because of growing pressures from land use intensification.

Urban sewage treatment and micro-pollutant removal

Switzerland has a clear set of water charging principles and widespread metering, which have allowed high cost recovery levels for water supply and sanitation services. The water bill covers the full costs of operation and maintenance and 78% of long-term capital expenditure (including renewal) of sanitation infrastructure. The WPA requires holders of water facilities to set up the reserves necessary to ensure long-term financing of not only the initial investment, but also its depreciation and renewal. Switzerland should continue to pursue full cost recovery, with water tariffs alone being sufficient to cover all costs, including capital depreciation.

A fund was created in 2016 to cover up to 75% of the cost of upgrading sewage treatment plants through to 2040. It is financed by a federal sewage charge levied on all "central" (large and medium-sized) treatment plants. The Federal Council sets the charge rate, basing it on the expected upgrade cost. Thus the charge is conceived as a revenue-raising instrument rather than an incentive for households to reduce micro-pollutants. The charge level is also based on the number of people connected to the plant, and has a ceiling of CHF 9 per capita per year. The charge is consistent with the polluter-pays principle because plants can pass it on to those connected.

However, in the case of about 15% of central plants (120 out of the total of 800), almost the entire Swiss population pays for the upgrades. This enlarged charge base allows better cost sharing among those connected, but the polluter-pays principle would better apply if the charge were applied at the watershed level, as in England and Wales. Industrial sewage treatment plants should also fall under the risk-based upgrade requirement and pay the charge. The federal sewage charge could usefully be extended to conventional water pollutants, as is the case in several OECD countries. Such pollution charges create incentives to reduce direct discharges to water bodies, including from sewage treatment plants.

Some 90% of municipalities have prepared a water drainage plan, which was required by the end of 2016 under the WPA. By fostering separate treatment of municipal sewage and storm water, such plans can help improve sewage treatment plants' performance. Separate treatment of storm water also limits direct discharges of micro-pollutants to water.

Nutrient and pesticide management in agriculture

More than 95% of Swiss farms comply with environmental cross-compliance requirements, strengthened in 1999, which limit farm nitrogen and phosphorus surpluses to

10%, prohibit pesticide use on buffer strips of 6 m along rivers (compared to 3 m under the WPA) and require setting aside at least 7% of the farm for biodiversity promotion. However, none of the nutrient and pesticide-related targets published jointly in 2008 by FOEN and the Federal Office for Agriculture (FOAG) has been fully met (FOEN and FOAG, 2016). Hence the Federal Council considered introducing tax incentives in Agriculture Policy 2022-25 to improve agricultural nutrient and pesticide management. A prerequisite would be to further reduce reliance on payments based on input and output use, which tend to incentivise the use of farm inputs. In addition, Switzerland should assess the cost-effectiveness of the payments farmers continue to receive for undertaking measures to prevent runoff and leaching of nutrients and pesticides. This WPA provision (Article 62a) should be seen as a transitional measure as it contradicts the polluter-pays principle (i.e. it is about paying farmers to comply with limit values also set by the WPA).

The compulsory computing system for farm manure, compost and nutrient-rich digestate from biogas plants, introduced in Agriculture Policy 2014-17, is a cost-effective way to meet the legal requirement for balanced use of nutrients on farms. It allows nutrient trading at no cost to the public purse other than operating the electronic nutrient trading platform, as farms exchange nutrients only if both the donor and recipient find it to their interest. To further enhance cost-effectiveness, nutrient trading could be combined with a tax levied on surplus nitrogen at the farm level, as Denmark does.

In the context of the forthcoming plant protection product action plan, Switzerland is evaluating the feasibility of introducing a pesticide tax. Such a tax should be differentiated according to toxicity, as is the case in Denmark, and levied on wholesalers or industry to reduce transaction costs. A prerequisite would be to abolish the value added tax concession that still prevails on pesticides.

River system rehabilitation

Cantonal surface water rehabilitation plans were finalised in 2014. They aim to designate stretches of river and lakeshore where the benefits to nature and landscape are greatest in relation to rehabilitation costs. The cost-benefit analysis is based on a stretch's ecomorphological status, its natural state and existing installations, such as buildings and roads, on riparian zones. However, the criteria for selecting river and lakeshore stretches for rehabilitation should be more conducive to reducing fragmentation of water-dependent ecosystems and explicitly aim at creating ecological corridors.

Several legal provisions allow for payments to landowners for the multiple ecosystem services of surface water rehabilitation in terms of hydrology, flood protection, protection of nature and landscape, and land improvement. For example, there may be payments for i) rehabilitation within the meaning of the WPA, ii) flood protection under the Watercourse Management Act, iii) alluvial biotope restoration under the Act on the Protection of Nature and Cultural Heritage and (iv) extensive farming and land improvement under the Agriculture Act. Switzerland should ensure synergies and coherence between these payments. This would mean evaluating the additionality of ecosystem services (e.g. flood protection as well as nature and landscape conservation). Where policy objectives overlap for a given river or lakeshore stretch (e.g. rehabilitation is realised as part of agricultural structural adjustment), no double funding should be allowed if the services provided are one and the same (e.g. land improvement should be financed as part of either agriculture policy or water policy), pursuant to the 1990 Act on Financial Aid and Compensation (Subsidies Act, Article 12).

Farmers providing space for waters are granted direct (compensatory) payments for preserving biodiversity on their lands under agricultural policy and pursuant to the WPA, Article 62b. This is justified insofar as farmers are getting paid for going beyond what cross-compliance requires them to do anyway (setting aside at least 7% of the farm for biodiversity promotion).

The proceeds of a tax on electricity bills support the legally required upgrading of hydropower plants to reduce their negative impact on watercourses. This concept of "electricity pays for electricity" does not appear to contradict the polluter-pays principle as hydropower plant operators are eligible for full compensation if limitation of their acquired rights of water power use entails excessive costs. Electricity consumers also subsidise hydropower development as part of energy policy. Differentiated FIT rates (which benefit plants with output of at least 1 MW) rightly provide an incentive to locate hydropower plants outside unmodified watercourses, but wrongly encourage siting on smaller rivers, the breeding ground for many fish, as FIT incentives increase as the size of the plant decreases.

About 25% of hydropower plants built prior to 1991 did not meet the 2012 deadline for implementing minimum flow requirements. As regards hydropower developments since 1991, Switzerland is to be commended for its consensus-building approach to setting "acceptable" minimum flows, which calls for weighing the economic and environmental interests involved. However, weighing of interests to set acceptable minimum flows balancing hydropower development and water-dependent ecosystems' protection has rarely been implemented in practice. One way to trigger weighing of interests would be to assess the significance of alluvial zones in protected areas and connection areas (the concept of ecological infrastructure) with a view to registering more alluvial zones in the Federal Inventory of Landscapes and Natural Monuments of National Importance. Another challenge is to revise long-standing rights of water use for power that impede rehabilitation of small rivers; these rights were often granted for an unlimited period.

Drinking water supply and groundwater protection

The WPA requires cantons to provide for general quantitative and qualitative protection of groundwater by subdividing their territory into groundwater protection zones and groundwater protection areas. The former are primarily intended to protect drinking water abstraction areas; the latter aim to protect groundwater for future use. Land use constraints on farming in groundwater protection zones may give rise to financial compensation based on income loss, under WPA Article 62a.

However, there are no national legal requirements to delimit groundwater protection zones or groundwater protection areas in cantonal master plans and land use plans. Few cantons have identified the necessary water resources for actual and future drinking water supply and included them in their master plans. In this respect, Switzerland could extend to groundwater protection what is already being done regarding flood protection (since 1998) and space for surface waters (since 2011):, both have to be incorporated in land use plans, including municipal land use plans when they are renewed.

Direct abstraction of groundwater is subject to taxation. The tax may be increased where recourse to public financial support has been necessary to protect groundwater. This is, in a way, the price to pay for the lack of groundwater protection in the past and the failure to take into account the protection of groundwater in today's cantonal land use planning. It is consistent with the beneficiary-pays principle, whereby those who benefit

from groundwater protection should contribute to its cost. However, preferential tax rates for certain categories of users should be discontinued and the tax rate designed to reflect water scarcity.

Recommendations on water management

Urban sewage treatment and micro-pollutant removal

- Pursue efforts to upgrade urban sewage treatment plants with a view to reducing risks of water pollution by micro-pollutants; consider extending micro-pollutant abatement and control policy to industrial sewage.

Nutrient and pesticide management in agriculture

- Speed up release of the action plan for reduction of risks and sustainable use of phytosanitary products; in that context, consider phasing out the VAT concession on pesticides and phasing in pesticide taxation at production and wholesale points, based on toxicity.
- Consider introducing a tax on nitrogen surpluses at the farm level as a sanction for non-compliance with legal requirements under the WPA.

River system rehabilitation

- Consider the whole range of water-dependent ecosystems when selecting stretches of river and lakeshore for rehabilitation; in particular, foster the role of well-functioning river systems as connection areas within the ecological infrastructure concept called for by the Swiss Biodiversity Strategy.
- Consider revising long-standing rights of water use for power that impede rehabilitation of small rivers and designating selected river stretches as being of national importance, thereby triggering the weighing of interests between hydropower development and ecosystem rehabilitation for these river stretches.
- Ensure synergies and coherence between the different river rehabilitation objectives (e.g. in terms of hydrology, flood protection, protection of nature and landscape, farmland improvement); in particular, evaluate the additionality of ecosystem services and the overlap of policy objectives related to the rehabilitation of the Swiss river system.
- Extend water quality monitoring to small rivers and small lakes and improve understanding of their ecological functioning to develop protection measures, given their ecological importance and their high exposure to agricultural pollution.

Drinking water supply and groundwater protection

- Consider making the delimitation of groundwater protection areas and groundwater protection zones legally binding and having them fall within the framework of cantonal and municipal land use plans.

5. Biodiversity conservation and sustainable use of ecosystems

Status, trends and pressures

Switzerland has made progress in supporting biodiversity conservation and sustainable use of ecosystems over the past decade, with improved monitoring, development of a national biodiversity strategy, increased public spending and efforts to mainstream biodiversity into sectoral policies. However, despite an increase in forest cover (and status of forest habitats) as well as a slowing rate of decline of some species, the results so far are insufficient for significant improvement in the state of biodiversity.

There remain significant pressures on biodiversity from land use change, landscape fragmentation, pollution, interference with watercourses, habitat loss and disturbance, invasive species and climate change. The majority of inland water ecosystems are considered threatened, biodiversity-rich grasslands are being lost and the surface area of alluvial zones and wetlands decreased by 36% and 82%, respectively, between 1900 and 2010. In 2012, 36% of evaluated species were categorised as threatened, with 3% regionally extinct and 5% critically endangered (FOEN, 2014). Switzerland has one of the OECD's highest proportions of threatened species.

Room for improvement exists in monitoring and data collection. There is no publicly available national map of ecosystem distribution. Moreover, despite hosting the secretariat of the United Nations Environment Programme initiative The Economics of Ecosystems and Biodiversity, Switzerland has not progressed significantly on developing its own monetary values for ecosystem services. Addressing these gaps could help build a stronger case for policy action.

Institutional, legal and strategic framework

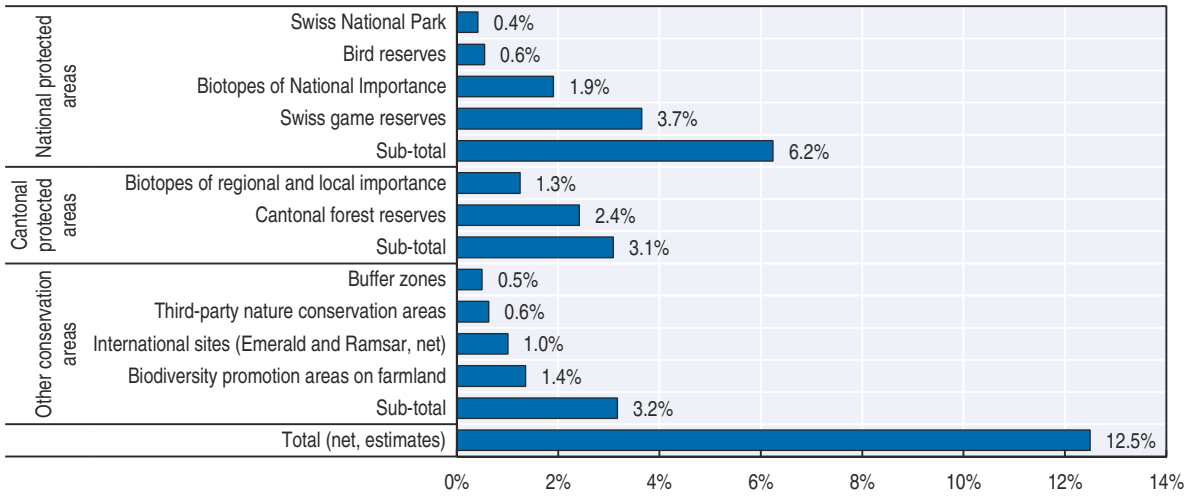
Switzerland features a very strong bottom-up decision-making system in which the cantons and municipalities have significant control, and important decisions such as national park designation are put to public referendum. This democratic system can greatly enhance synergies with local circumstances and interests, ensuring eventual local buy-in and support for implementation of agreed measures. However, it also presents a challenge for biodiversity protection in terms of the length of time required for consultation, prioritisation of the economic benefit and uneven implementation of national policies.

In September 2017, the Federal Council finally approved the action plan of the 2012 Swiss Biodiversity Strategy, more than three years past the government's commitment to do so (April 2014). An initial thorough consultation process, including with academia and civil society, had taken place in 2013, yet the Federal Council delayed the plan's publication, claiming further consultation with cantonal and communal authorities was necessary (FOEN, 2016c). It is too early to assess whether the measures, indicators and financial resources of the biodiversity action plan are sufficient to achieve the country's ambitious 2020 strategic goals.

Policy instruments for biodiversity conservation and sustainable use

Use of economic instruments has been limited. Switzerland relies mainly on regulatory instruments to meet biodiversity objectives. Protected areas at the national level have expanded over the past two decades, mainly through growth of the Biotopes of National Importance network and through cantonal and communal actions, but remain short of the global Aichi target to protect 17% of the earth's land surface by 2020. Only 6.2% of the land and inland waters enjoy national-level protection as defined by the International Union for Conservation of Nature management categorisation (Figure 4), though total protection across the country could prove to be as high as 12.5% once the government completes an inventory of additional protected areas at the cantonal and communal levels (FOEN, 2017a). Switzerland also has lower levels of strict protection than other OECD countries, relying heavily on a game reserve designation originally intended to limit excessive hunting. The quality of protected areas is also lacking: often they are too small, are poorly connected with each other and with European networks, and do not fully meet conservation objectives.

Figure 4. **Designated areas for biodiversity have varying levels of protection**



Note: Adjustments have been made to account for the estimated overlaps.
Source: FOEN (2017a), Biodiversity in Switzerland: Status and Trends.

StatLink http://dx.doi.org/10.1787/888933571112

In 1914, Switzerland was one of the first European countries to create a national park. Today, however, that park remains the only national park in Switzerland, which is unusual for an OECD country. The 2007 EPR recommended development of a park policy including creation of regional natural parks, peri-urban natural parks and a second national park. The rejection of a second national park in a November 2016 referendum, after 16 years of work with local authorities and conservation experts, was a major setback for park policy and for biodiversity conservation overall.

Landscape management policies hold the promise of helping address biodiversity challenges in a practical manner. The Swiss Landscape Concept, for example, integrates nature and landscape protection into all relevant sectoral policies (FOEN, 1998). Amendments to the Spatial Planning Act in 2013 that seek to reduce oversized development zones and better allocate existing reserves of development land are also positive. However, gaps in the project approval procedure and a fiscal system that encourages municipalities to allow urban sprawl limit progress (Waltert et al., 2010). Urban policy measures such as green space networks and corridors, potentially financed through taxes on residents and corporations, could help reduce habitat fragmentation and biodiversity loss in and around cities.

The federal government has increased efforts over the past decade and doubled the government share of expenditure related to biodiversity. However, financial resources remain insufficient to ensure the protection and restoration of important ecosystems and species. The lack of resources may partly explain the failure to meet biodiversity targets. FOEN estimates that implementing measures needed to meet the Swiss Biodiversity Strategy objectives would lead to an annual funding gap of CHF 182 million to CHF 210 million to 2040 (CBD, 2017). In response, the Federal Council decided in May 2016 to invest CHF 135 million – an additional CHF 55 million plus CHF 80 million through repurposing from the FOEN budget – in urgent biodiversity measures over 2017-20. In September 2017 the Federal Council decided to extend urgent measures on biodiversity to 2023 and to dedicate CHF 180 million to them over the period 2021-23 – an additional CHF 160 million plus CHF 20 million reoriented from the FOEN budget. It was also decided to allocate CHF 50 million to support further measures

to promote biodiversity in Switzerland in 2019-23. Financing of the biodiversity action plan was approved in a context of limited access to new sources of funds, at both the federal and cantonal levels, which may lead to an incremental implementation of the plan.

While Switzerland has not really used economic instruments for biodiversity, other than payments for biodiversity conservation in agriculture, there is significant potential for expansion of such instruments as a complement to enhanced protected areas and effective landscape management. Economic instruments can be a cost-effective way to address pressures on biodiversity, and a way to more appropriately reflect the value of ecosystem services, while offering an opportunity to raise revenue that can be used for additional conservation and restoration efforts. There is potential for taxing pesticides and agricultural nitrogen surpluses (Section 4), charging fees in forestry for the use of ecosystem services, imposing access fees in tourism and using development charges in cities to expand green space. Greater use of biodiversity offsets for infrastructure or tourism development might also be possible.

Switzerland should, moreover, make further progress in identifying and phasing out or reforming incentives harmful to biodiversity. Support for tourism infrastructure, for example, may be counter to some biodiversity objectives (Ecoplan, 2013).

There is also a need for more information measures, particularly given the use of referendums for major policy decisions. With polls showing that a majority of Swiss believe nature is doing well and the country is past the degradation stage and in a state of recovery (FOEN, 2017a; Schaub and Welte, 2017), access to information on the actual state of biodiversity and proactive awareness campaigns would be beneficial. Partnerships with non-government organisations (NGOs), industry associations and other stakeholders may be an effective way to improve awareness.

Mainstreaming biodiversity into economic sectors

Switzerland has generally done well at mainstreaming biodiversity considerations into sector-specific and other policies through the Swiss Biodiversity Strategy, Agricultural Policy packages, Forest Policy 2020 and Energy Strategy 2050, as well as other approaches. However, the strategies have yielded limited tangible results, implying greater effort is needed to translate general declarations of intent into concrete measures and ensure effective and consistent implementation across cantons.

The Confederation commendably reformed its agricultural support policies to encourage biodiversity conservation and sustainable use (Section 3), and requires farmers to designate at least 7% of agricultural land as biodiversity promotion areas, as part of environmental cross-compliance criteria, to be eligible for direct payments. However, the joint FOEN/FOAG review of compliance with 2008 agri-environmental targets found that the agriculture sector had not attained the majority of objectives relevant to biodiversity, particularly in terms of habitat quality and connectivity (FOEN/FOAG, 2016). Further effort could be made to ensure that biodiversity promotion areas are selected based on ecological criteria. Pollution from pesticides and fertilisers used in agriculture also continues to pose a significant threat to inland water sources (Section 4) as well as soil fertility and non-target organisms, and agriculture is responsible for 92% of the country's ammonia emissions, which contribute to significant adverse effects on forests, wetlands and grasslands (ES, 2015).

The forestry and energy strategies include links to biodiversity conservation and sustainable use, but effective implementation depends on agreements with the cantons,

energy providers and forest owners as well as adequate financing, and there is potential for conflict with other goals, such as increasing wood harvesting rates and expanding hydropower and wind energy, which needs to be carefully managed. Switzerland has among the lowest levels of forest reserves in Europe, with only 5.6% of forest surface dedicated for the purpose (FAO and EFI, 2015). A commitment to protect 8% by 2020 and 10% by 2030, and a requirement for near-natural silviculture, exists alongside a policy to increase wood harvesting rates (FOEN, 2017a). Introducing a system of fees and payments for ecosystem services, paid by forest users and linked to forests' ecological value, would help protect valuable forest ecosystems while raising revenue for conservation. For energy, new hydropower and wind projects will need to be carefully implemented to minimise their impact on terrestrial and aquatic ecosystems and species such as fish and birds. The 2011 WPA amendments requiring hydropower plant operators to reduce their negative impact on watercourses (hydropeaking, changes in sediment transport, obstacles to fish migration) by 2030 are encouraging.

Expansion of tourism and transport infrastructure also presents a significant challenge for biodiversity in the form of increased landscape fragmentation and habitat disturbance. More emphasis will be needed on creative mitigation measures like those pursued in other countries, such as well-functioning wildlife corridors and wildlife refuges adjacent to ski resorts, as well as expanded use of economic instruments such as fees for tourism operations. It is ultimately in the tourism industry's interest for landscape services to be maintained – hence the case for consumers of landscape services to pay for their maintenance. There have been few specific and targeted actions to address strategic commitments to integrate biodiversity into tourism and transport policy, though the recently launched biodiversity action plan may introduce more meaningful measures and help improve vertical co-ordination and co-operation.

Recommendations on biodiversity conservation and sustainable use

Status, trends and pressures on biodiversity

- Create a national ecosystem map that identifies priorities for action in terms of protection, pressures and corridors, considering threatened ecosystems and species, as a basis for establishing a more formal and legally binding tool for spatial planning.

Institutional, legal and strategic framework

- Move forward with implementation of the action plan for the Swiss Biodiversity Strategy, pursuing measures with quantified objectives, clear indicators to measure progress and adequate human and financial resources for implementation.
- Work with NGOs, the private sector and education systems to raise biodiversity awareness, engage further with local communities through dialogue on sustainable local development, and develop tools and guidelines for reporting their impact and contributions to biodiversity conservation.

Instruments for biodiversity conservation and sustainable use

- Develop policies, programmes and action plans to meet Switzerland's commitment to protect at least 17% of its territory by 2020, and increase the volume and quality of ecosystem and species protection, by expanding protected areas and other area-based conservation measures to address gaps and improve connectivity within Switzerland and with neighbouring countries; for instance, the Emerald Network should be expanded and co-ordination with Natura 2000 strengthened.

Recommendations on biodiversity conservation and sustainable use *(cont.)*

- Increase federal, cantonal and communal funding consistent with the Swiss Biodiversity Strategy and action plan, either through larger public appropriations or by finding alternative sources of revenue, such as economic instruments, which could include taxes on pesticide use and farm nitrogen surpluses and charges for use of ecosystem services; the complete system of agricultural direct payments should be focused so as to holistically optimise biodiversity-related incentives.
- Dedicate resources towards identifying and phasing out subsidies and tax incentives with harmful effects on biodiversity, and redirect tax instruments towards behaviour favouring the conservation and sustainable use of biodiversity, including for landscape management, where incentives within the fiscal system encourage urban sprawl.

Mainstreaming biodiversity into economic sectors

- Pursue efforts to strengthen the potential of the agricultural sector to support biodiversity by selecting biodiversity promotion areas based on environmental objectives (e.g. ecological infrastructure) rather than agricultural objectives.
- Ensure that forestry policy is consistent with biodiversity objectives, and with the national goal of protecting 8% of forest area by 2020 and 10% by 2030; explore opportunities to use economic instruments for forest conservation, such as fees and payments for ecosystem services paid by forest users, while promoting increased private certification.
- Pursue measures to mitigate the impact of tourism and transport infrastructure on biodiversity, such as improving wildlife corridors, introducing fees for tourism operators and developing biodiversity refuges adjacent to ski resorts.

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ANNEX A

Actions taken to implement selected recommendations from the 2007 OECD Environmental Performance Review of Switzerland

Recommendations	Actions taken
Chapter 1. Environmental performance: Trends and recent developments	
Implement further measures to combat fine particulates and ground-level ozone from transport (on-road and off-road vehicles), industry and households, and ammonia generated by agriculture (e.g. by adopting tougher emissions limits, promoting innovation and increasing the use of particulate filters on diesel engines).	Emissions have been reduced since 2007 thanks to more stringent emission standards for road vehicles (NO_X and VOCs) and new technology for manure storage and spreading (ammonia). Since 2014, the shift from headage to acreage payments to livestock holders has reduced incentives to maintain large livestock populations, which is expected to further reduce ammonia emissions.
Further exploit the multiple benefits associated with air quality, climate change and energy efficiency objectives.	Wherever possible, synergies have been exploited in the case of new installations (e.g. heating, insulation and alternative energy production, mainly solar energy).
Promote the use of environmental indicators and indicators of sustainable development in government strategies, paying special attention to regional development and land use planning.	A State of the Environment report has been released every two years since 2007. Geodata have been included in national reporting since enactment of the 2007 Act on Geoinformation.
Continue to develop monitoring and evaluation, especially in areas for which indicators are insufficient, and base the formulation of future objectives on extensive analysis and on close co-operation among all the parties involved.	In 2008, the Federal Office for the Environment (FOEN) and the Federal Office for Agriculture (FOAG) jointly published new environmental targets for the agricultural sector based on existing legal requirements. Since then, FOAG has routinely monitored compliance with the targets via a survey of 17 indicators on 300 farms. A first progress report was released in 2016.
Fully implement the ongoing Environment-Health action plan; formulate and implement complementary measures that are cost-effective.	No specific environmental health programme currently exists but there is a co-ordination conference between FOEN and the Federal Office of Public Health.
Chapter 2. Environmental governance and management	
Further improve the effectiveness and efficiency of environmental policies with improved monitoring of the environment and its interactions with the economy (environmental data and economic analysis), expanded use of economic instruments and documentation of compliance with environmental legislation.	Since 2007, almost 70 cost-effectiveness assessments (VOBUs) have been undertaken on a wide array of draft environmental laws, plans and policies. The Federal Audit Office has asked the administration to ensure consistency between VOBUs, regulatory impact assessments (RIAs) and sustainability assessment (SAs).
Continue efforts to strengthen co-ordination between the Confederation and the cantons, so as to implement harmonised and efficient environmental policies throughout the country (e.g. by adopting an integrated system for authorising industrial activities, along the lines of the European Union's IPPC approach).	FOEN provides guidance to cantons through "enforcement aids" intended to promote uniform application of environmental law across the country. Cantons co-ordinate with each other through the Conference of Cantonal Governments, which also focuses on the division of tasks between the Confederation and the cantons.
Adopt strategies that are more highly integrated to manage natural hazards and technological risks, taking into account other sectoral policies (e.g. regional planning, transport, forests); accelerate completion of cantonal cadastres of contaminated sites and begin to decontaminate priority sites.	Cadastres of the 38 000 contaminated sites have been completed and are available online. Remediation has been completed on 1 000 contaminated sites (out of 4 000 sites likely to be remediated).

Recommendations	Actions taken
Improve the use and integration of strategic instruments in the areas of transport, energy, the environment and regional development, from a sustainable development standpoint.	VOBUs, RIAs and SAs do not fully meet strategic environmental assessment (SEA) requirements. FOEN and the Federal Office for Spatial Development are developing a SEA method with a view to anchoring it at the level of legislation.
Make further efforts to achieve sustainable mobility and recreational activity, in particular by integrating protection of the environment, nature and landscapes into transport and regional planning at all levels; extend Agenda 21 programmes to rural and scarcely populated areas.	The Sustainable Development Incentive Programme (PEDD) has continued supporting local initiatives to implement Agenda 2030 for sustainable development, which replaced Agenda 21 in 2015. In 2017, PEDD was supporting projects to promote sustainable food.
Ratify the Aarhus Convention and ensure that practices at the federal and cantonal levels concerning access to environmental information, public participation, and access to justice comply with obligations under this convention; ensure that NGOs have access to the courts and can participate in decision-making related to EIA procedures at an early stage.	Switzerland ratified the Aarhus Convention in 2014. Since 2015 environmental information has had to be released in open and digital form (if possible), including at cantonal and communal levels, as part of "open government data". In 2015, for the first time, the Federal Council (instead of FOEN) published the SOE report.
Continue efforts to disseminate environmental information; continue to ensure high-level environmental education at all stages.	Since 2013, the foundation Education21 has promoted education on sustainable development at the primary and upper secondary levels.
Chapter 3. Towards green growth	
Associate the federal strategy for sustainable development with sectoral strategies; set quantified objectives; encourage the cantons to implement strategies for sustainable development in liaison with their sectoral policies.	The Sustainable Development Strategy (launched in 2002, updated in 2016) covers measures overlapping with the Green Economy Action Plan (released in 2013, updated in 2016), Energy Strategy 2050 (prepared in 2013, approved in 2017) and the four-year Agricultural Policy packages (the current one covers 2014-17).
Implement the green tax reform called for in the 2002 federal strategy for sustainable development; identify and eliminate subsidies and tax provisions that are potentially detrimental to the environment (in particular, eliminate the planned deductibility of expenses for commuting by car).	In June 2017 the parliament rejected a proposed budget-neutral green tax reform. The proposal, put forward in the context of the preparation of Energy Strategy 2050, envisaged replacing the CO_2 tax and feed-in tariffs by 2021 with a climate and energy tax system, revenue from which would have been redistributed in full. Commuting expenses continue to be deducted from the federal employment tax.
Formulate a pro-active, long-term environmental policy vision.	In the aftermath the Fukushima accident, in 2011, the parliament undertook to reform Swiss energy policy and asked the Federal Council to prepare an energy strategy to foster a shift from nuclear power to renewables by 2050. A first package of Energy Strategy 2050 measures and related amendments to the Energy Act were approved by referendum on 21 May 2017.
Take steps to meet Switzerland's targets under the Kyoto Protocol, including introduction of a CO_2 tax	Switzerland met its Kyoto target mainly thanks to the 2008 CO_2 tax on heating fuels, the 2010 buildings programme and emission limits on passenger cars.
Step up efforts to promote more sustainable consumption patterns by adopting appropriate regulatory and economic instruments, and through adequate demand management.	The only legal basis of sustainable consumption patterns is in the area of public procurement. Switzerland promotes environmental labels and life cycle assessment in partnership with NGOs.
Continue to internalise the external environmental costs of road passenger transport (e.g. by introducing distance-related incentives or combining energy labels with a bonus/malus system applicable at the time of purchase).	Since 2012 the heavy goods vehicle tax (LVSA) has fostered Euro VI norms and retrofit of Euro II and III diesel vehicles with particle filters. Some cantons have a bonus/malus scheme. The LVSA is distance based but motorway tolls are not.
Pursue a freight traffic shift from road to rail through targeted investment, financial support for public transport and intermodality, and extension of the heavy vehicle fee.	Some 68% of freight transport through the Swiss Alps is by rail. The share is expected to rise further with the December 2016 opening of the Gotthard Base Tunnel, at 57 km the world's longest rail tunnel. Heavy goods vehicle trips through the Alps have been reduced by 30% since introduction of the LSVA (2001), but Switzerland has yet to meet its 2018 target of a maximum of 650 000 trips per year.
Pursue implementation of the SwissEnergy programme; consider increasing taxes on gasoline and diesel fuel to improve internalisation of external costs; further promote energy efficiency in buildings and industrial installations.	The road fuel tax rate is higher for diesel than for petrol but the CO_2 tax does not cover road fuels. Earmarking of the CO_2 tax finances energy efficiency of buildings. Energy efficiency is the first pillar of Energy Strategy 2050.
Pursue agricultural policy reform in order to enhance economic competitiveness and, at the same time, ecological efficiency; in this context, continue to give high priority to meeting agri-environmental objectives.	The 2014-17 Agricultural Policy package suppressed general area payments and improved targeting by tying payments to specific agricultural practices. The policy also replaced headage payments with grassland area payments for livestock as an incentive to lower stocking density.
Further increase overall official development assistance (ODA) and improve reporting on ODA in the area of environmental protection (e.g. water).	ODA rose to 0.5% of gross national income in 2015 and the environmental share to 18% of bilateral ODA (still below the OECD DAC average of 28%).
Chapter 4. Water management	
Promote integrated water basin management, in particular by combining objectives for water quality and for the quantity of water resources, as well as the objectives of nature conservation and guaranteed minimum space for watercourses so they can perform their ecological functions.	Switzerland adopted a pragmatic approach to watershed management. Some cantons have introduced it into their legislation. The 2011 amendment to the Water Protection Ordinance requires co-ordination of water management activities, in some cases explicitly within a watershed. Since 2011 the cantons have been required i) by 2018, to provide waters with sufficient space, which can at most be farmed to promote biodiversity; ii) by 2014, to develop river rehabilitation plans; and iii) by 2030, to eliminate damage caused by installations related to hydropower use.

Recommendations	Actions taken
Make further progress in financing the upkeep and renewal of water treatment infrastructure, including through pricing measures.	User charges recover 78% of the cost of long-term capital expenditure (including renewal) for water sanitation, according to a 2011 survey.
Establish funding mechanisms for the renaturing of watercourses.	Public financial support is available for river rehabilitation projects (via environmental policy) and for providing space for waters (via agricultural policy), while electricity consumers (via a tax on electricity bills) support ecological improvement of installations related to hydropower use.
Prepare national flood management plans by water basin, in co-operation with the cantons; help avert flood risks by implementing the recommendations of cantonal master plans for land use.	There has been good progress on preparing flood hazard maps, which form part of land use plans in an increasing number of municipalities.
Identify sources of micro-pollutants (MPs) from cities, industry and agriculture; introduce preventive measures in line with the polluter pays principle; continue to reduce non-point source pollution from agriculture, especially in small lakes and in groundwater.	MP river pollution was surveyed over the last ten years. MPs will be removed in 50% of urban sewage by 2040; households will pay 75% of related investment. There is no legal requirement to remove MPs from industrial sewage. An action plan to reduce agricultural pesticide risks is being prepared.
Harmonise water quality monitoring by the cantons and the Confederation.	A joint National Surface Water Quality Monitoring programme was started in 2011 but it excludes small rivers.
Continue to reduce pollution of agricultural origin, in particular through targeted and regional actions.	Payments to tackle agricultural water pollution have been continued, going against the polluter-pays principle.
Chapter 5. Biodiversity conservation and sustainable use	
Prepare and adopt a National Biodiversity Strategy (which could succeed the Swiss Landscape Concept), along with corresponding plans of action; set precise objectives and timetables which anticipate, inter alia, the effects of climate change.	The Federal Council adopted the Swiss Biodiversity Strategy (SBS) in 2012 and the corresponding action plan in September 2017.
Limit consumption of agricultural and natural space; contain dispersed urbanisation by enhancing the integration of biological and landscape diversity goals into spatial planning by cantons and communes, based on reform of the federal law on regional development and adjusted property taxation.	The revised Spatial Planning Act (2014) makes expansion of building zones conditional upon population increase but the fiscal system creates perverse incentives for urban sprawl. The non-binding 2012 Swiss Territory Project calls upon the three administrative levels to protect natural space from activities with territorial impact.
Clarify the federal inventory of landscapes and natural monuments of national importance (ILNM) so that landscapes can be factored more rigorously into cantonal and communal planning.	Since 2010 ILNM objects have had to be considered in cantonal and municipal land use planning. Their number and area have not changed but an ILNM update has clarified their protection aims.
Set up Regional Natural Parks (RNP), peri-urban natural parks, a national ecological network and a second national park; extend international networks of protected areas, such as Ramsar, Man and the Biosphere, and World Heritage sites, and establish the Emerald Network (Bern Convention); expand financial resources to invigorate policy for the development of protected areas.	Since 2007 15 RNPs and one nature discovery park have been created, but in 2016 voters rejected creation of a second national park. One SBS objective is to establish an ecological infrastructure of protected areas and connection areas, though Emerald Network sites are still to be designated. Public expenditure on biodiversity has increased significantly since 2007.
Strengthen sustainable forest management (SFM); expand forest reserves (FR) and ensure the "public good" function of forests.	In 2011, Forest Policy 2020 confirmed the aim of no decrease in the forest area. Requirements of "silviculture close to nature" (2010), SFM indicators (2012-14) and enforcement aid on forest biodiversity (2015) were issued. FR rose from 3.4% of the forest area in 2007 to 5.6% (the 2030 target is 10%).
Do a better job of evaluating, taking into account and remunerating services rendered by ecosystems.	There was no practical application of case-by-case monetary valuation of ecosystem services.
Maximise agriculture's beneficial effects on the environment, especially with regard to biodiversity and the landscape.	Agriculture Policy 2014-17 increased payments for biodiversity promotion areas. The SBS action plan covers agriculture.
Expand Alpine co-operation, in particular concerning transport, energy and tourism.	Switzerland signed the nine protocols to the Alpine Convention but has not ratified them.

PART I

Progress towards sustainable development

PART I

Chapter 1

Environmental performance: Trends and recent developments

This chapter provides an overview of Switzerland's main achievements and remaining challenges on the path towards green growth and sustainable development. Drawing on indicators from national and international sources, it compares the state of the environment and key environmental trends with those of other OECD countries, focusing on the period since 2000.

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.

1. Introduction

Switzerland is a rich country, with the fourth highest gross domestic product (GDP) per capita in the OECD. Economic growth quickly recovered after the 2009 recession, driven mainly by exports and household consumption. Living standards of the small but growing population continue to rise: GDP per capita increased by an annual average of 0.6% over 2009-15 (OECD, 2017a). Switzerland is poorly endowed with mineral raw materials and energy resources other than water. It is a top OECD performer in terms of energy intensity, greenhouse gas (GHG) intensity and material productivity. The Swiss perceive environmental quality as generally high (FSO, 2016), though rising incomes and consumption have resulted in higher waste generation and stronger pressure on freshwater and biodiversity.

2. Key economic and social developments

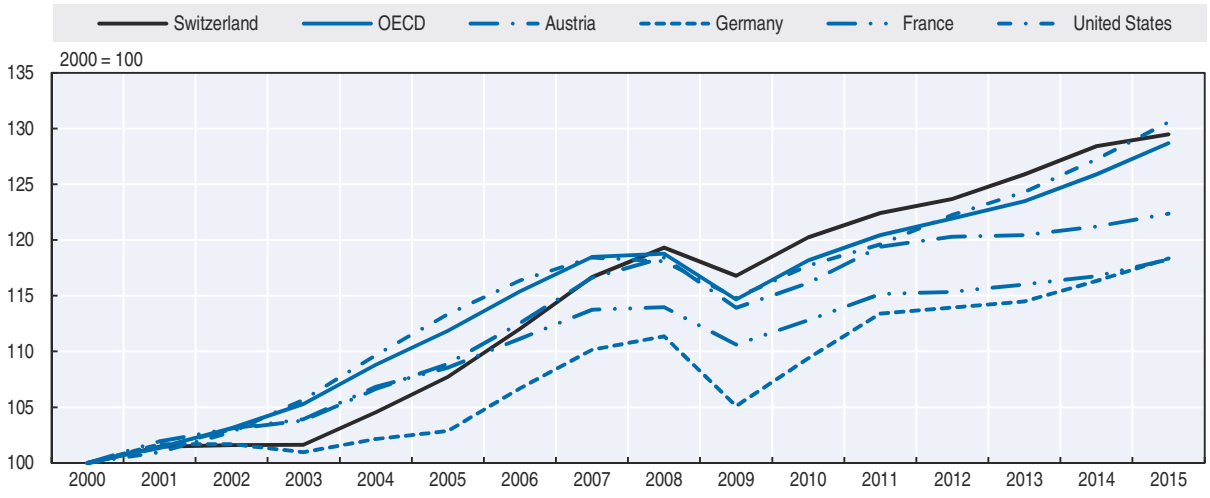
2.1. Economic performance

Switzerland has a small, open economy. Between 2000 and 2015 real GDP increased by 29%, at a rate equal to that of the OECD as a whole (Figure 1.1). Economic growth quickly recovered after the 2009 recession, increasing faster than the GDP of the country's main European Union (EU) trading partners and keeping pace with US growth (Figure 1.1). The recovery was driven primarily by exports, which bounced back strongly after 2009, and household consumption (OECD, 2015a). This was largely due to the ultra-low interest rate policy of the Swiss National Bank and a ceiling on the rise of the Swiss franc from 2011 to 2015. GDP is projected to grow by 1.7 % over 2016-17 and by 1.9% in 2018 (OECD, 2017a). In terms of living standards, measured as real GDP per capita, in 2015 Switzerland was the fourth best performer in the OECD, after Luxembourg, Ireland and Norway.

The Swiss government is a net lender, with a fiscal balance surplus of 1.1% of GDP in 2015, against a deficit of 3.1% on average in OECD countries. The level of public expenditure is one of the lowest in the OECD, at 34% of GDP in 2015, and has followed a slightly negative trend since 2000. Despite its low government spending, however, Switzerland scores well on various public policy outcomes, including health, education and transport (OECD, 2015a). Public spending will need to be managed more efficiently to maintain low tax rates as the population grows and ages, increasing demand for public services and weakening the tax revenue base (OECD, 2015a).

The 2016 tax/GDP ratio was one of the lowest in the OECD at 29%, against an OECD average of 36%. The tax structure, compared with the OECD average, is characterised by a lower proportion of revenue from taxes on goods and services and social security contributions and a higher revenue share from taxes on income, profits and gains (OECD, 2016b). Revenue from environmentally related taxes is largely dominated by taxes on energy (51%) and on motor vehicles and transport (47%). Although the contribution of environmentally related taxes to GDP slightly decreased from 1.89% in 2000 to 1.76% in 2014, it remains above the OECD average of 1.6%.

Figure 1.1. **Swiss GDP growth is in line with growth in the OECD as a whole**



Note: GDP expressed at 2010 prices and purchasing power parities.
Source: OECD (2016a), *National Accounts Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571131

2.2. Structure of the economy and employment

As in most OECD countries, the service sector dominates the economy, accounting for nearly three-quarters of value added in 2015, close to the OECD average. Industry accounts for most of the rest, while the share of agriculture and forestry is less than 1%.

Exports of goods and services account for 64% of GDP, a share well above the OECD average of 54%. The share of imports (52%) is also above the OECD average (49%) (OECD, 2015a). Major recipients of Swiss exports include Germany (19%), the United States (15%) and France (7%) (FCA, 2017). Chemicals and pharmaceuticals are the largest export sectors with a combined 45%, followed by machines and electronics (15%) and watches (9%) (FCA, 2017). Both exports and growth are likely to have been affected by the 2015 removal of the ceiling on Swiss franc, which led to a sharp appreciation, especially against the euro.

Although per capita GDP in Switzerland is above the OECD average, it is driven by high labour resource utilisation rather than labour productivity (OECD, 2015a). With a large proportion of the working-age population in employment (80%) and a low unemployment rate, the Swiss economy continues to attract immigrants.

2.3. Population, quality of life and regional disparity

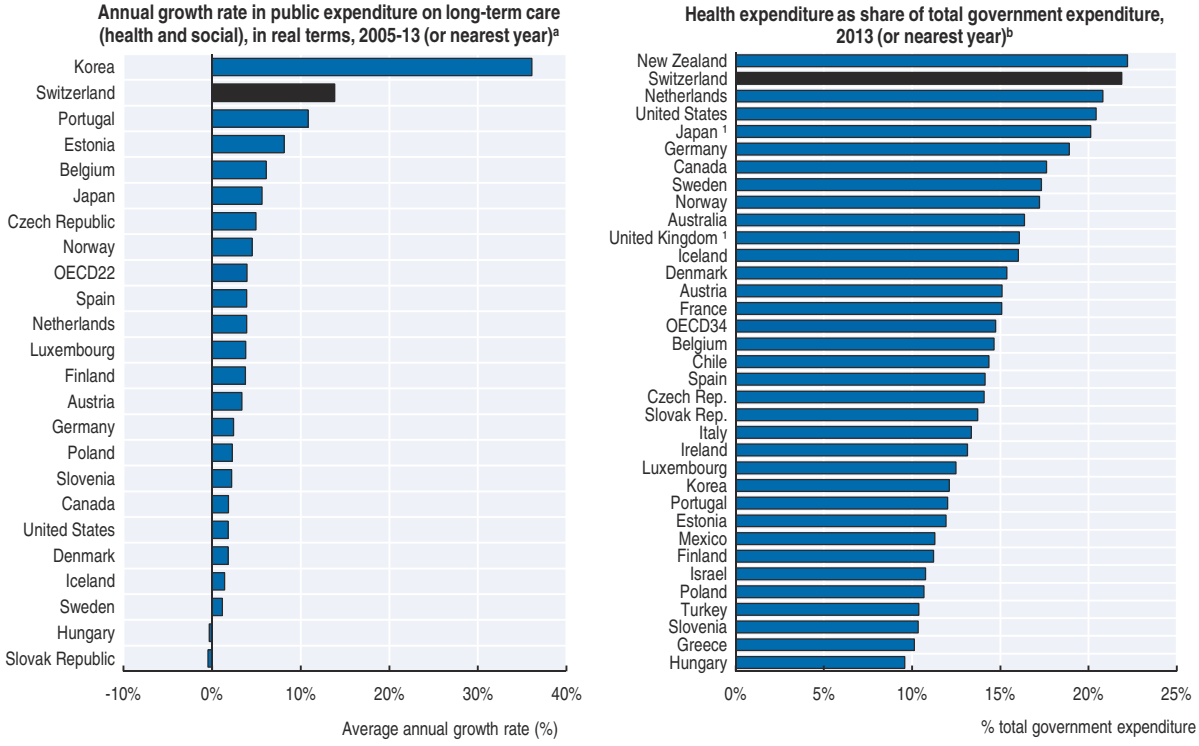
Over 2000-15, the Swiss population grew from 7.2 million to 8.1 million. With a growth rate of almost 1% per year, Switzerland has seen one of the highest population increases in Europe. However, birth rates are falling: on average, Swiss women now give birth to 1.5 children, below the replacement rate. As life expectancy at birth is 83.3 years – the second highest in the OECD, after Japan – the ratio of people over 65 to the working-age population is about one to four, which indicates that, like other OECD countries, Switzerland is facing the challenge of an ageing population.

Over 60% of the Swiss population lives in predominantly urban areas, 36% live in intermediate areas and just over 3% in rural areas. With nearly 200 habitants per square kilometre in 2015, Switzerland is relatively densely populated. Around two-thirds of the population lives on the Swiss Plateau, a relatively small area between Lake Geneva in the

west and Lake Constance in the east, where the density reaches 450 inhabitants/km^2 – one of the highest levels in Europe (Swiss Info, 2014).

Changes in the age pyramid are reflected in health expenditure. In 2013 the share of government spending on health was one of the highest in the OECD, significantly above the average (Figure 1.2). Between 2005 and 2013 public expenditure on long-term care grew by nearly 14% per year, much faster than in most other OECD countries, being outpaced only by Korea (Figure 1.2).

Figure 1.2. **Public health expenditure is high and increasing**



Note: a) The unweighted average of the OECD countries presented excludes Korea due to its extremely high growth rate. (b) Data refer to total health expenditure, i.e. current health expenditure plus capital formation.
Source: OECD (2015b), *OECD Health Statistics* (database).

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While other European countries have tended to increase the importance given to their National Environmental Health Action Plans (NEHAPs), Switzerland decided not to renew its NEHAP in 2007. Institutional co-operation between the Federal Office for the Environment (FOEN) and the Federal Office of Public Health has continued since 2007 (for example, in the areas of chemicals and sustainable development), but there is no holistic view of environmental health problems in Switzerland nor an assessment of the costs and benefits of public action in this area.

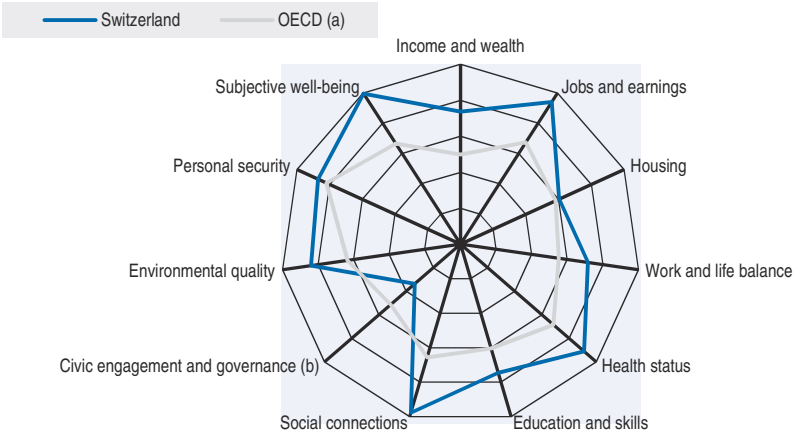
Educational attainment is high: 42% of the population aged 25 to 64 has tertiary education, compared with the OECD average of 35%. Switzerland ranks 12th among OECD countries in the latest Programme for International Student Assessment survey (OECD, 2016c).

Nevertheless, 14.4% of Swiss men aged 20 to 24 are not in employment, education or training. Although the share is below the OECD average of 15.5%, it places Switzerland

behind 17 better-performing OECD countries. For women the share is lower – at 9.9% Swiss women perform well compared to the OECD average of 18.5%.

Regarding prime indicators of well-being and happiness, several major cities in Switzerland have been repeatedly ranked among top places in the world to live. For example, like Norway, Denmark and Iceland, Switzerland is a top performer on all factors found to support happiness: caring, freedom, generosity, honesty, health, income and good governance (Helliwell et al., 2017). When asked to rate their general satisfaction with life on a scale from 0 to 10, the Swiss averaged 7.6, one of the highest scores in the OECD, where average life satisfaction is 6.5 (OECD, 2015c). Most importantly, the country performs above the OECD average in nearly all areas of the Better Life Index (Figure 1.3). The environmental quality component is based on the state of air and water. Urban air quality, assessed in terms of average exposure to $PM_{2.5}$ pollution, is below the OECD average, while perceived water quality (measured through public satisfaction) is significantly above it.

Figure 1.3. **Well-being perception is generally higher in Switzerland than in the OECD overall**



Note: (a) Unweighted average. (b) Partly based on average voter turnout. Switzerland's direct democracy means a disproportionately large number of national votes, with relatively low average turnout.
Source: OECD (2016d), *OECD Better Life Index*.

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Indicators of regional well-being show that regional income inequality in Switzerland, measured in terms of household income levels and relative poverty, is greater than in neighbouring Germany, Austria and France (OECD, 2015c). Regional gaps in employment are also higher than in the neighbouring countries, with the unemployment rate in the Lake Geneva region and Ticino, at 6.7%, being twice as high as in eastern Switzerland (3.2%) (OECD, 2015c).

The Federal Statistical Office conducted an Omnibus Survey in 2015 to investigate environmental quality and behaviour. It found that 92% of the population evaluated the country's environmental quality as very or quite good, with quality in the living environment rated even better at 95%. However, 24% of respondents reported being disturbed by traffic noise and 19% by air pollution. The results also showed disparity among cantons; for example, air pollution was ranked lower in the Italian cantons (32%) than in the French (20%) and German ones (18%) (FSO, 2016). The OECD measure of well-being in regions found that regional variation in air quality was wider in Switzerland than in Germany but narrower than

in Austria and France (OECD, 2015c). In a study commissioned by FOEN, the Swiss reported their highest satisfaction with respect to access to green spaces (3.3 points out of 4), followed by water and air quality. Noise and rubbish levels ranked slightly less positively, with the lowest score, 2.9, assigned to litter and rubbish levels (FOEN, 2015). Recent polls show that a large majority of Swiss (between 75% and 90%, depending on the survey) believe nature in Switzerland is doing very well (FOEN, 2017a), showing a misperception of the actual risk facing biodiversity, which could contribute to biodiversity protection being given low priority vis-à-vis economic development objectives (Chapter 5).

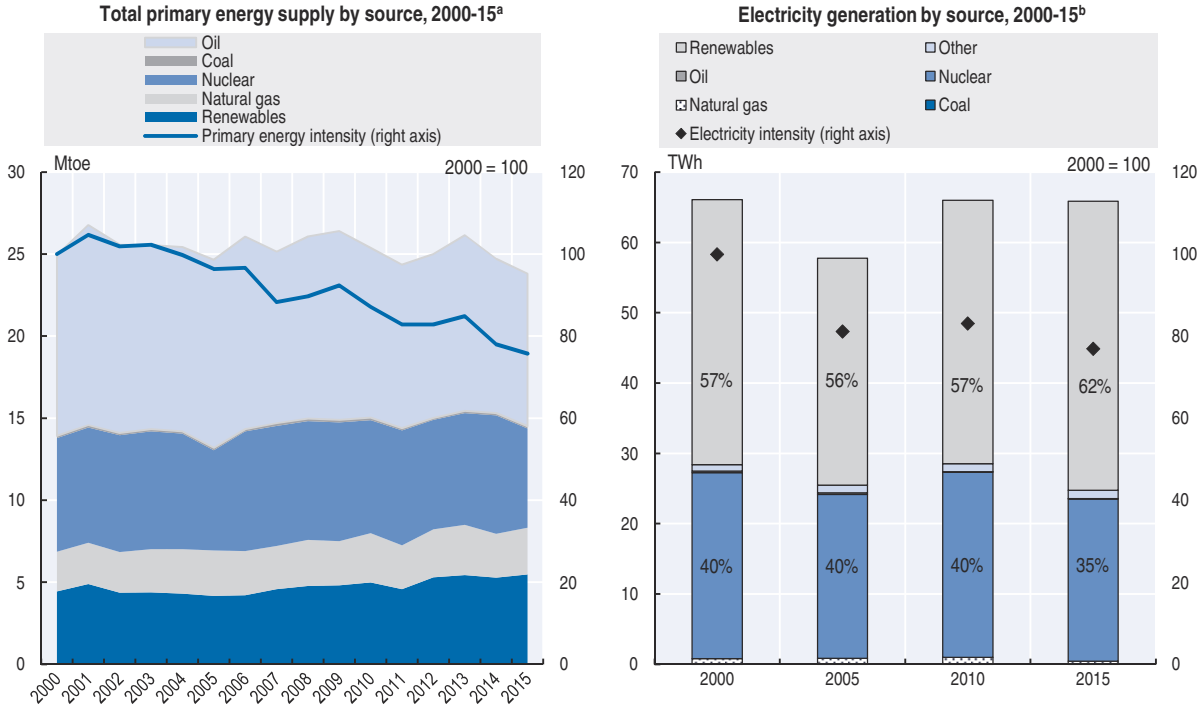
3. Transition towards an energy-efficient and low-carbon economy

3.1. *Energy supply*

A relatively balanced energy mix

Fossil fuels constitute more than half of total primary energy supply (TPES), though well below the OECD value of 80%. Oil makes up 39% of TPES and natural gas 12%, with coal at less than 1% – lower than in any other OECD country. Nuclear power (25%) and renewable energy sources (23%) account for nearly half of TPES (Figure 1.4).

Figure 1.4. **Half of the energy supply comes from fossil fuels**



Note: (a) Total primary energy supply. Breakdown excludes electricity trade. (b)Primary intensity is expressed per unit of GDP in 2010 prices and purchasing power parities).
Source: IEA (2017a), *IEA World Energy Statistics and Balances* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

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The level of TPES has been fairly stable since 2000 at about 25 million tonnes of oil equivalent (Mtoe). Between 2000 and 2015, energy intensity, measured as TPES per unit of GDP, decreased by 24%, showing a relative decoupling from GDP growth. In 2015, within the OECD, only Ireland had a better performance in terms of TPES per unit of GDP.

As there is no domestic production of crude oil or natural gas,[1] domestic demand is covered by imports. Switzerland imports 57% of its crude oil from non-OECD countries and relies on OECD suppliers for the rest. Two Swiss refineries produce one-third of the refined oil products put on the Swiss market. The remainder is imported from refineries in EU countries, mainly Belgium and the Netherlands. Germany supplies over two-thirds of Swiss natural gas, followed by the Netherlands (16%), France (12%) and Italy (3%). Long-term contracts ensure supply of 65% of natural gas imports (IEA, 2014). Due to environmental concerns, shale gas operations have been suspended since 2011 in the cantons of Vaud and Fribourg, where exploration licences had been granted (IEA, 2012).

While the Swiss energy supply relies to a significant extent on nuclear power, the country's energy policy is being redefined. On 21 May 2017, Swiss voters approved a gradual phase-out of nuclear energy and a shift to renewable energy sources by 2050. This decision, which implies amending the Energy Act, follows a government proposal motivated by the accident at the Fukushima Daiichi nuclear plant in March 2011. Voters in a 2016 referendum had rejected a strict timetable for phasing out nuclear power, which opponents feared would lead to power shortages and increased short-term reliance on fossil fuels. Rapid development of renewable energy supply

The share of renewables in TPES grew from 18% in 2000 to 23% in 2015, on track with the indicative target of 24% by 2020 set by the Renewable Energy Action Plan of 2007. As a consequence, Switzerland ranks tenth among OECD countries in terms of renewables' contribution to TPES (Figure 1.5). While 60% of the renewable energy supply (RES) comes from hydropower, the contributions of all renewables have increased since 2000 (Figure 1.5). In parallel, the SwissEnergy programme[2] aims to increase renewables' share of total final energy consumption (TFC) by at least 50% from 2011 to 2020, although the target is not legally binding; objectives set for 2000-10 were achieved (IEA, 2012).

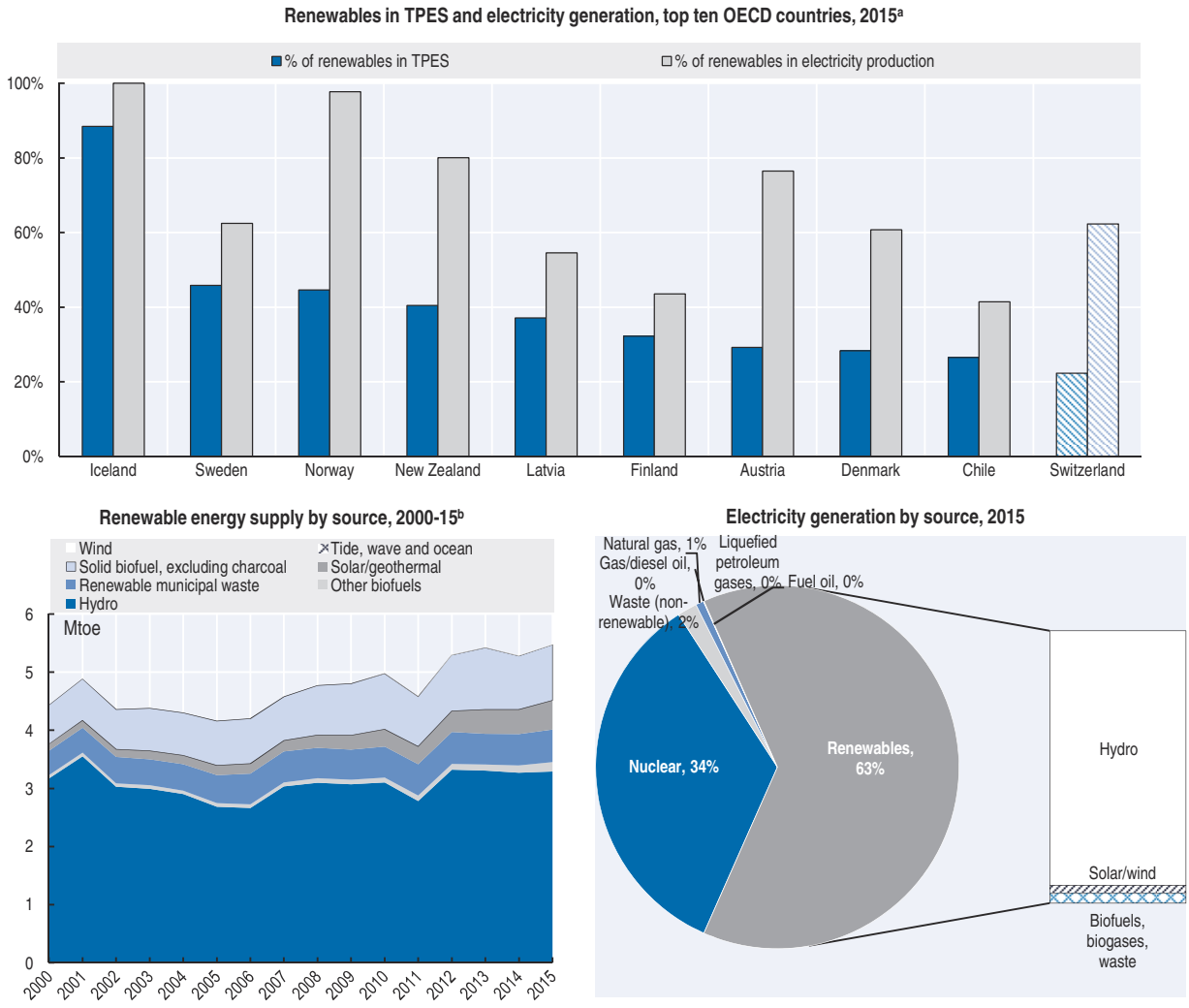
Swiss electricity is generated almost exclusively from renewables (63%) and nuclear power (34%), with the remainder coming chiefly from natural gas and waste incineration (Figure 1.5). As a result, Switzerland ranks among the top OECD countries in terms of electricity generated from renewable resources. Like the RES, the mix of renewables in electricity generation is largely dominated by hydropower, complemented with solar and wind energy, as well as biomass (Figure 1.5). The 2008 Electricity Supply Act states that by 2030 an additional 8% of total electricity supply will have to be generated from renewable resources.

3.2. Road dominates the transport sector's energy use

Since 2000, energy intensity – measured as TFC per unit of GDP – has decreased by 25%, showing a relative decoupling from GDP growth. TFC fell slightly from 19.4 Mtoe in 2000 to 18.7 Mtoe in 2014, with the largest savings between 2013 and 2014, thanks predominantly to a 15% decrease in residential sector consumption (Figure 1.6), chiefly attributed to two key measures. First, the 2007 Renewable Energy Action Plan provided incentives for the replacement of heating oil – representing half of all energy use in residential heating – with heat pumps. While they are fitted in around 80% of new houses, replacement in older buildings had been slow (IEA, 2012). Also, since 2010 the building sector has been subject to the CO_2 tax and incentives have been introduced to improve buildings' energy efficiency (Chapter 3).

Transport is the main energy user and a major source of GHG emissions (Figure 1.6). Transport demand associated with GDP growth has sustained fossil fuel use and GHG

Figure 1.5. **Renewables rely heavily on hydropower**



Note: (a) Data for Latvia refer to 2014. (b) Solar/geothermal = geothermal + solar photovoltaics + solar thermal. Other biofuels = charcoal + biogases + biogasoline + biodiesel + other liquid biofuels.
Source: IEA (2017a), *IEA World Energy Statistics and Balances* (database).

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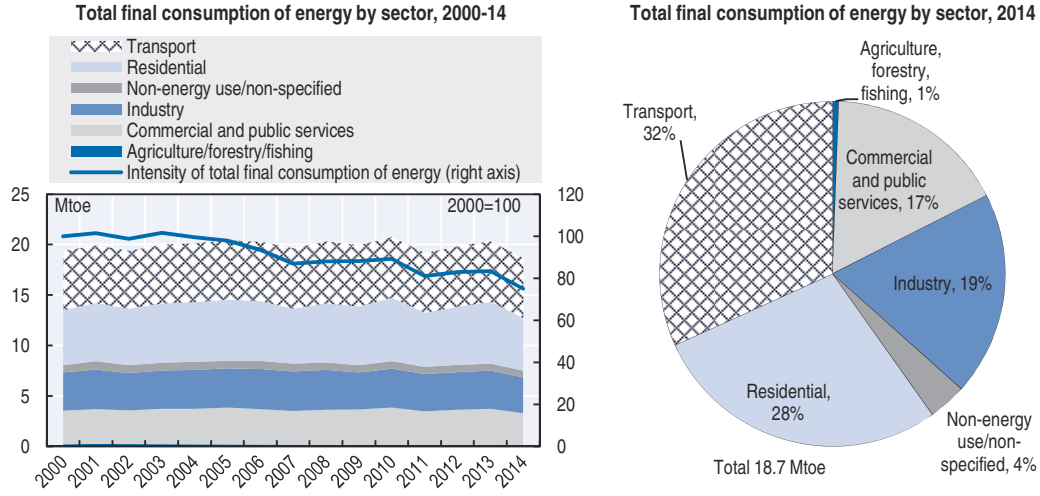
emissions from the sector. As in other OECD countries, road dominates transport energy use, representing 94% of TFC in the sector (Figure 1.7).

As part of efforts to decarbonise transport, Switzerland is aiming for a modal shift from road to rail and for improvements in public transport. The impact of road transit through the Alps continues to pose concerns and Switzerland lacks a proactive policy to promote electric vehicles as a way to decarbonise national road transport. Moreover, the number of diesel vehicles, which emit more particulate matter and nitrogen oxides (NO_X) per litre of fuel burned than vehicles running on petrol, continued to increase. In 2016, diesel vehicles made up 29% of the fleet, up from 4% in 2000. With 74 road vehicles per 100 inhabitants in 2014, Swiss vehicle ownership is above the OECD average of 68. Nevertheless, since 2000 the increase of the road vehicle stock has been slower (23%) than the OECD average.

Figure 1.6. **Energy consumption is decreasing and becoming less intensive**



Note: TFC is expressed per unit of GDP in 2010 prices and purchasing power parities.
Source: IEA (2017a), IEA World Energy Statistics and Balances (database); OECD (2016a), OECD National Accounts Statistics (database).

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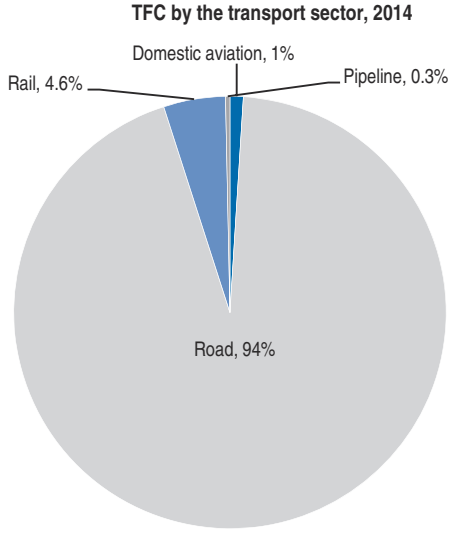
Figure 1.7. **Road accounts for the lion's share of energy consumption in the transport sector**



Source: IEA (2017a), *IEA World Energy Statistics and Balances* (database).

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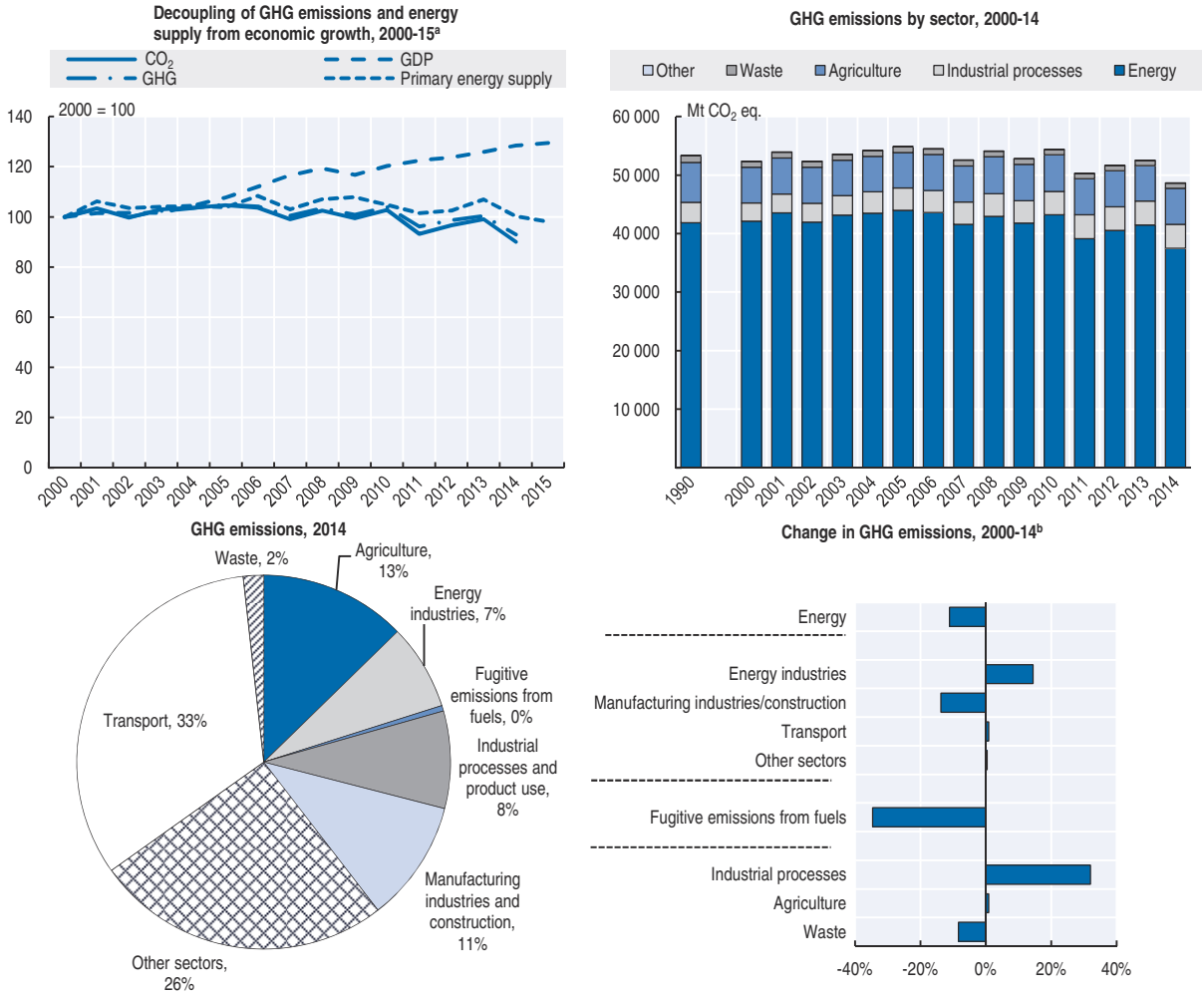
3.3. Climate change mitigation

GHG emission profile

Over the last decade Switzerland has achieved the goal of decoupling domestic GHG emissions from economic growth. Since 2000, Swiss GDP has grown by 28%, while GHG emissions decreased by 7% and CO_2 emissions by 10% (Figure 1.8). As a result, today Switzerland is the OECD's top performer in terms of intensity of GHG emissions.

The energy sector (i.e. fossil fuel combustion) remains by far the largest producer of GHG emissions (77%), though Switzerland managed to reduce them by 11% between 2000 and

Figure 1.8. **GHG emissions are decreasing**



Note : a) GHGs exclude emissions/removals from land use, land use change and forestry; CO2 emissions from energy use, sectoral approach, excludes marine and aviation bunkers; GDP is expressed in 2010 prices and purchasing power parities. (b) "Other sectors" includes emissions from fuel combustion in the residential, commercial/institutional and agriculture/forestry/fishery sectors
Source: IEA (2017b), *IEA CO2 Emissions from Fuel Combustion* (database); IEA (2017a), *IEA World Energy Statistics and Balances* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

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2014 (Figure 1.8). As with TFC, the decrease was mainly driven by reductions in the residential sector. Over the same period, the performance of the transport sector was virtually unchanged (+1%), despite fast growth in passenger and freight traffic.

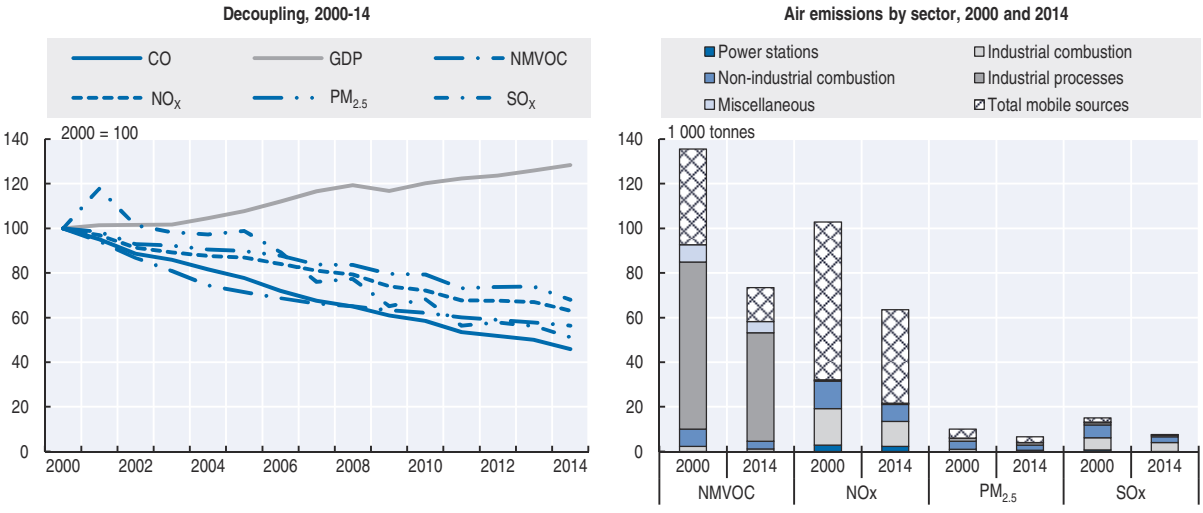
Switzerland fulfilled its first Kyoto commitment in 2012, and it set out more stringent, longer-term emission reduction targets in 2013 when amending the 2008 CO_2 Act and, more recently, as part of its Intended Nationally Determined Contributions (INDC). The CO_2 tax on heating and process fuels was raised from CHF 36 per tonne of CO_2 in 2008 to CHF 84 per tonne as from 2016, which is high by OECD standards but with a shallow tax base (road fuels are exempt). However, despite the relatively strong price signal created by the CO_2 tax, Switzerland's low carbon intensity, and thus the high marginal cost of further improvement, makes it challenging to reach the targets, i.e. reducing emissions by 20% by 2020 and 50% by 2030, compared with 1990 levels (Chapter 3).

Air emissions

Between 2005 and 2015 emissions of sulphur dioxide (SO_2) decreased by 56%, far surpassing the 2020 reduction commitment of 21% under the Gothenburg Protocol of the Long-Range Transboundary Air Pollution Convention (FOEN, 2017b). The 2020 target of reducing fine particulate matter ($PM_{2.5}$) emissions by 26% was also achieved early. However, in urban neighbourhoods and in areas of increased traffic, levels of coarse particulate matter (PM_{10}) are still above the legal ambient limit values (FOEN, 2016a). Emissions of NO_X and volatile organic compounds (VOCs) have decreased, though not yet as much as targeted for 2020 (by 41% and 30%, respectively). Ground-level ozone remains too high in the southern Alps (Ticino canton), where the hourly limit value of 120 µg/m^3 is frequently exceeded in rural areas over the summer (FOEN, 2017c). Nitrogen deposition still largely exceeds the critical loads of recipient ecosystems, with agriculture being the main source of nitrogen emitted into the atmosphere. Ammonia (NH_3) emissions have decreased by only 5% since 2005 and thus proportionally are furthest from achieving the 2020 target (Federal Council, 2015).

With the decline in emissions since 2000, all major air pollutants have been decoupled (in absolute terms) from economic growth (Figure 1.9). The main sources of Swiss air pollution are motorised transport (NO_X, PM_{10}), wood combustion (PM_{10}), agriculture (NH_3, PM_{10}) and industry (VOC, NO_X, PM_{10}) (Federal Council, 2015).

Figure 1.9. **Air emissions are declining**



Source: OECD (2017b), "Air and climate", *OECD Environment Statistics* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

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Air quality

Air quality has significantly improved since the 1990s and all cantons have drawn up programmes of measures for air protection. However, particulate matter and ozone pollution still contribute to the premature deaths of some 2 000 to 3 000 people each year. The related public health cost is estimated at over USD 13.7 billion per year (2.7% of Swiss GDP in 2015), mostly related to cardiovascular and respiratory ailments (Roy and Braathen, 2017).

The 1983 Environmental Protection Act, 1985 Ordinance on Air Pollution Control and 2009 Federal Air Protection Strategy, along with adherence to various international conventions, are aimed at protecting the population, as well as fauna and flora, from harmful

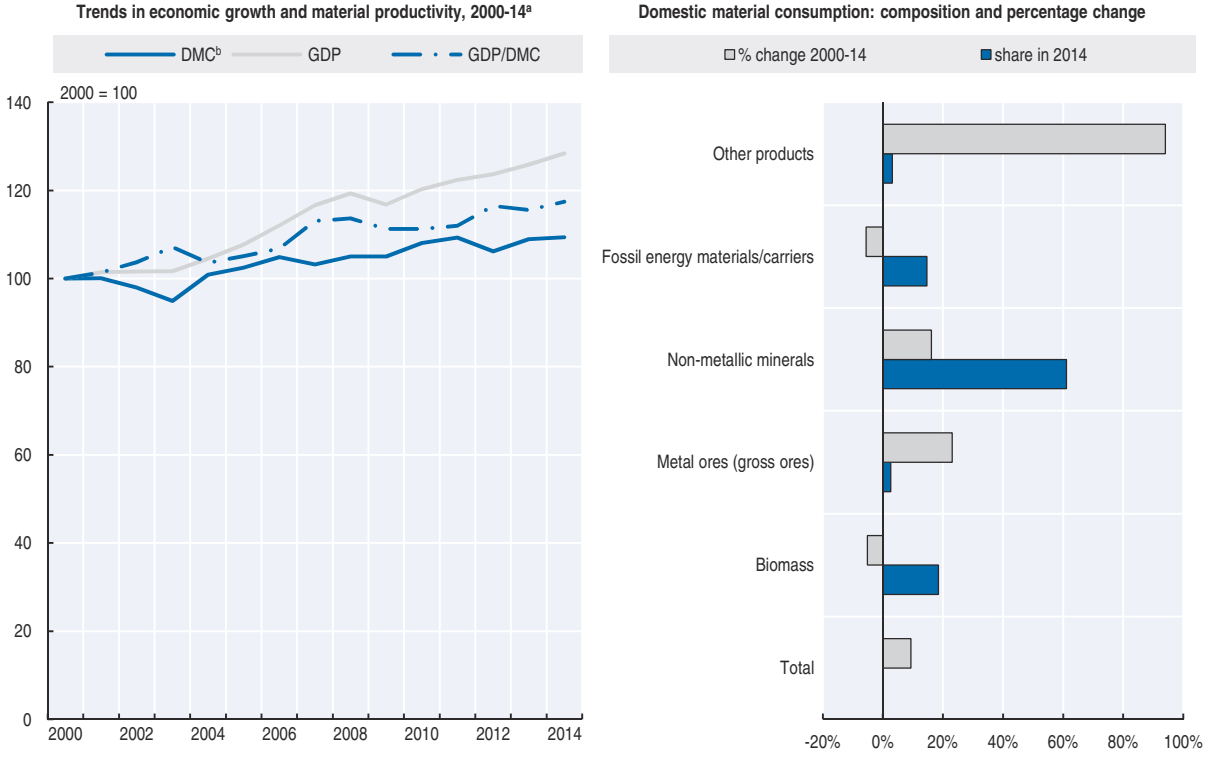
air pollutants. In addition, Switzerland applies standards for road vehicles and technical regulations for off-road vehicles that are often stricter than EU ones. Taxation has been introduced to decrease VOC emissions, and a heavy goods vehicle tax creates incentives to renew the fleet with less polluting vehicles (that comply with most recent EURO standards) or retrofit existing vehicles with particle filters (Chapter 3). Since 2008 the government has supported low-emission manure storage technology aimed at decreasing NH_3 emissions from livestock farming, and encouraged use of low-emission design for barns and farmyards.

4. Transition to a resource-efficient economy

4.1. *Material consumption*

In recent years Swiss material productivity, defined as the amount of economic wealth generated per unit of material used, was among the highest in the OECD. However, its increase since 2000 has been driven only by GDP growth and is well below the 40% rise in OECD Europe (excluding Iceland and Norway) (Figure 1.10).

Figure 1.10. **Material productivity is on the rise**



Note:(a) GDP is expressed in 2010 prices and purchasing power parities. b) Domestic material consumption (DMC) is the sum of domestic extraction and imports minus exports.
Source: Eurostat (2017), *Material Flow Accounts* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

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With an average annual requirement of 12.3 tonnes of material per capita, Swiss domestic material consumption (DMC) is slightly lower than the OECD Europe average (excluding Iceland and Norway). Since 2000, however, it has increased by 9%, compared to an average decrease of 11% for the EU28. Non-metallic minerals, predominantly (nearly 80%) building material such as gravel and sand, account for over 60% of DMC, the largest share in the

OECD; since 2000, their consumption has increased by 16%. Biomass (food, animal feed and wood) makes up a further 20%, with the rest being divided between fossil energy materials/carriers and metals. Since 2000, biomass consumption has decreased by 5% but that of metal ores has increased by 23% (Figure 1.10).

Introducing extended producer responsibility requirements for construction materials, as has been done in Germany, would create incentives to take end-of-life costs into account in product design (Watkins et al., 2012). Virgin-material taxes could also be considered to stimulate greater use of recycled substitutes; to that end, they should be confined to commodities where international trade is limited due to high transport costs relative to value (e.g. gravel, sand) (Smith, 2014). Another possibility would be to aim for a higher share of recycled material in construction materials (the share is currently only around 10%).

4.2. Waste management

Switzerland generated 77 million tonnes of primary waste in 2015, most of it excavated material (62%) and construction waste (20%). The remainder consists of municipal waste (8%), biodegradable municipal waste (7%) and hazardous waste (3%).

Over 80% of the approximately 15 million tonnes of construction waste produced each year in Switzerland is recycled, while the rest is sent to landfill. Aggregates taxes could be introduced to stimulate greater use of recycled substitutes instead of virgin construction materials (Smith, 2014). The recycling rate is lower for municipal waste at 51%, the rest being incinerated. Some 2.4 million tonnes of hazardous waste is produced annually, mainly due to remediation of contaminated sites, which must be completed by 2025. Around 25% of hazardous waste is recycled (FOEN, 2016b). Finally, Switzerland has built 235 plants for composting and fermenting biodegradable municipal waste (BMW), which includes food waste and sewage sludge. In 2000, Switzerland banned landfilling of combustible waste and BMW; both must now be incinerated or recycled. While a significant share of Swiss waste disposal is still by incineration, all 29 waste incinerators generate electricity and heat, covering around 2% of the country's energy consumption (FOEN, 2016b).

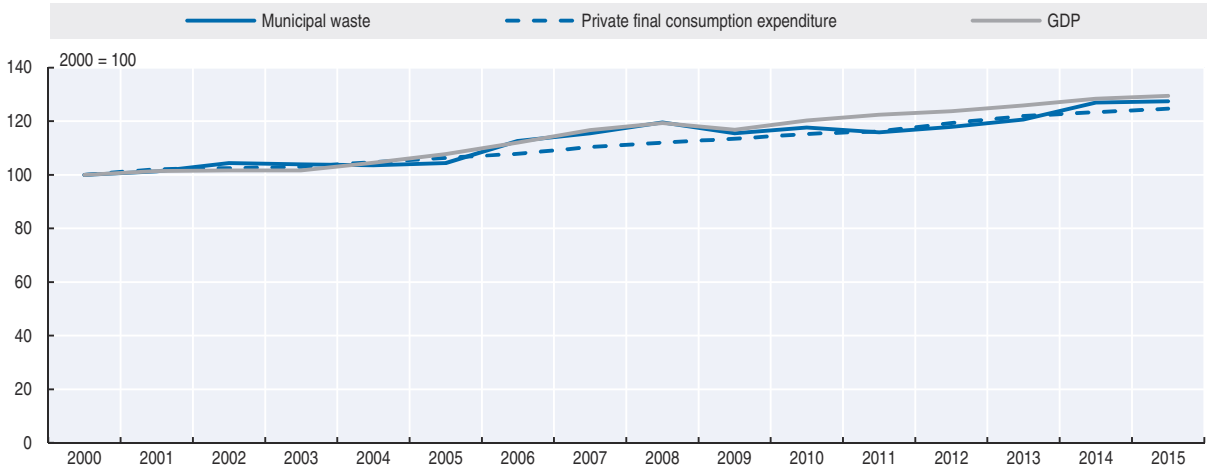
Municipal waste

In 2015 Switzerland generated 742 kg of municipal waste per capita, the second largest amount among OECD countries, after Denmark. Swiss performance deteriorated by 13% with respect to the 2000 level, while the OECD as a whole improved its average result by 6%. Since 2000, municipal waste generation has not been decoupled from private final consumption: the former has grown by 27% and the latter by 25% (Figure 1.11). The unsustainability of final consumption patterns remains to be addressed, a point the previous OECD Environmental Performance Review had already stressed in 2007 (Chapter 3).

Seeking to reduce the volume of household waste, the vast majority of municipalities have introduced a tax per bag used, also called a bin-liner fee (Chapter 3).[3] Provided for in the Environmental Protection Act (Article 32a), this contributes to meeting the end goal of full cost recovery (i.e. where fees are sufficient to cover all municipal waste disposal costs, including capital depreciation). The policy has been effective in reducing waste production and encouraging participation in recycling and composting, as an assessment in Vaud canton indicates (Carattini et al., 2016).

While levels of municipal waste recycling are relatively high, they have only slightly increased since 2000 (Figure 1.12). Total recycling rates oscillate around 50%, with material

Figure 1.11. **Municipal waste generation is rising**



Note: Private final consumption and GDP are expressed in 2010 prices and purchasing power parities.
Source: OECD (2016e), "Municipal waste - Generation and treatment", *OECD Environment Statistics* (database); OECD (2017c), *OECD Economic Outlook: Statistics and Projections* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

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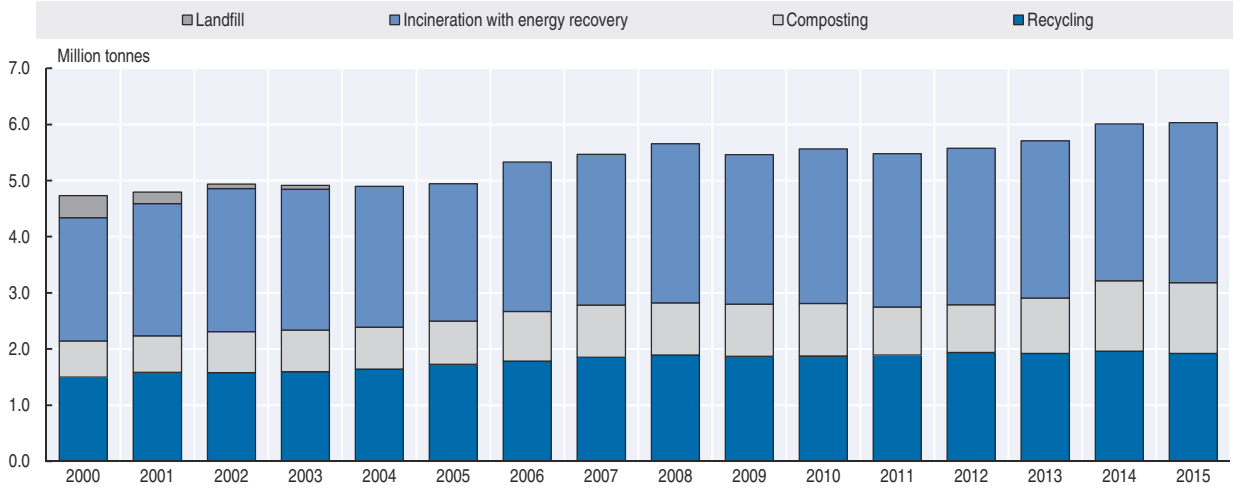
Figure 1.12. **Half of municipal solid waste is recycled**



Note: Municipal waste includes separately collected waste for recycling (excluding batteries and electrical and electronic equipment). Composting: change in methodology in 2014 (break in series).
Source: OECD (2016e), "Municipal waste - Generation and treatment", *OECD Environment Statistics* (database).

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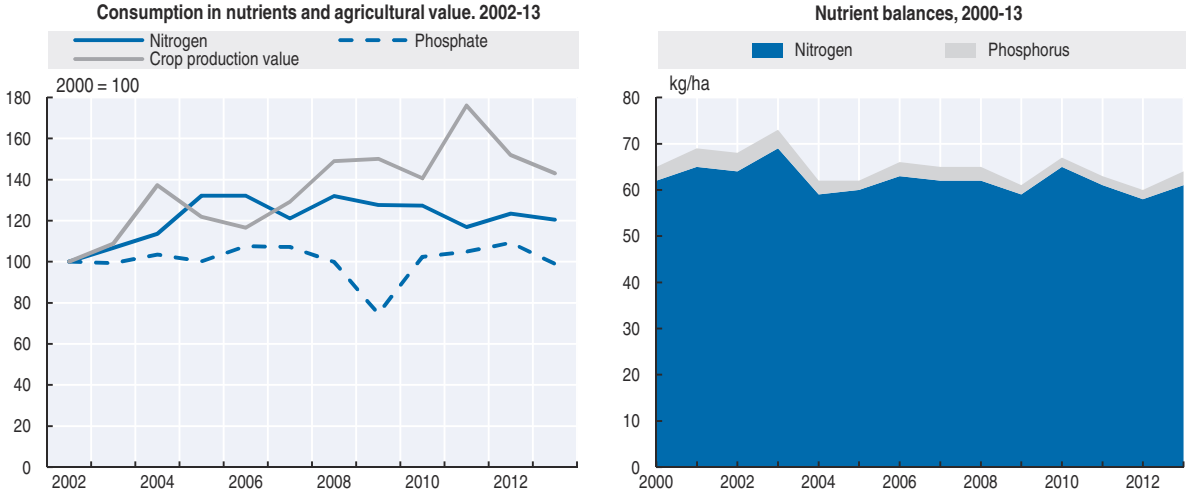
recycling (metal, glass, plastic, paper and cardboard) amounting to 32% and composting to 21% (Figure 1.12). While Switzerland is not bound by EU waste targets, its recycling rate would meet the 50% target introduced by the EU Waste Framework Directive (EEA, 2013).

4.3. *Agricultural inputs*

Alongside primary waste, inappropriate agricultural management methods, as well as misused fertiliser and plant protection products, result in negative environmental outcomes. Although Swiss agriculture applies more fertiliser than the OECD average (31.3 kg/ha compared to 24.7 kg/ha for nitrogen, and 10.6 kg/ha compared to 8.1 kg/ha for phosphorus),

fertiliser use has been decoupled from crop production (Figure 1.13). Swiss nutrient balances rank in the middle for OECD countries; they have declined only slightly since 2000 (Figure 1.13). Switzerland also ranks in the middle among OECD countries for intensity of agricultural pesticide use (Chapter 4).

Figure 1.13. **Use of nutrients in agriculture remains excessive**



Note: Nutrient balances and consumption are expressed in kg/ha of agricultural area. Crop production value is expressed in USD, in 2010 prices and purchasing power parities. Gross nutrient balances (N and P) are calculated as the difference between the total quantity of nutrient inputs entering an agricultural system (mainly fertiliser and manure) and the quantity of nutrient outputs leaving the system (mainly uptake of nutrients by crops and grasses). They are expressed in tonnes of nutrient surplus or deficit. This calculation can be used as a proxy for the status of environmental pressures, such as declining soil fertility in the case of a nutrient deficit or, for a nutrient surplus, the risk of polluting soil, water and air.
Source: FAO (2017), *FAOSTAT* (database); OECD (2017d), "Agri-Environmental indicators: Nutrients", *OECD Agriculture Statistics* (database).

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Seeking to encourage more efficient agricultural input use and more environment-friendly farm production methods, in 2013 the Federal Assembly approved a new policy package, Agriculture Policy 2014-17. Direct payments with explicit environmental objectives were set to increase under this package; they accounted for 6% of all direct payments in 2007-15 (Chapter 4). While farms account for over one-third of the national territory, nearly 9% of the agricultural area is under organic farming, which ranks Switzerland among the top ten best performers in the OECD.

5. The natural resource base

5.1. *Biodiversity and ecosystems*

Threatened species

As of the late 2000s, the International Union for Conservation of Nature classified as much as 79% of reptiles, 62% of amphibians, over a third of mammals and birds, and over a quarter of freshwater fish and vascular plants as threatened (i.e. vulnerable, endangered or critically endangered) (Chapter 5). These figures reflect the poor shape of Swiss biodiversity: for almost all animal classes, the share of endangered species is higher than the OECD average.

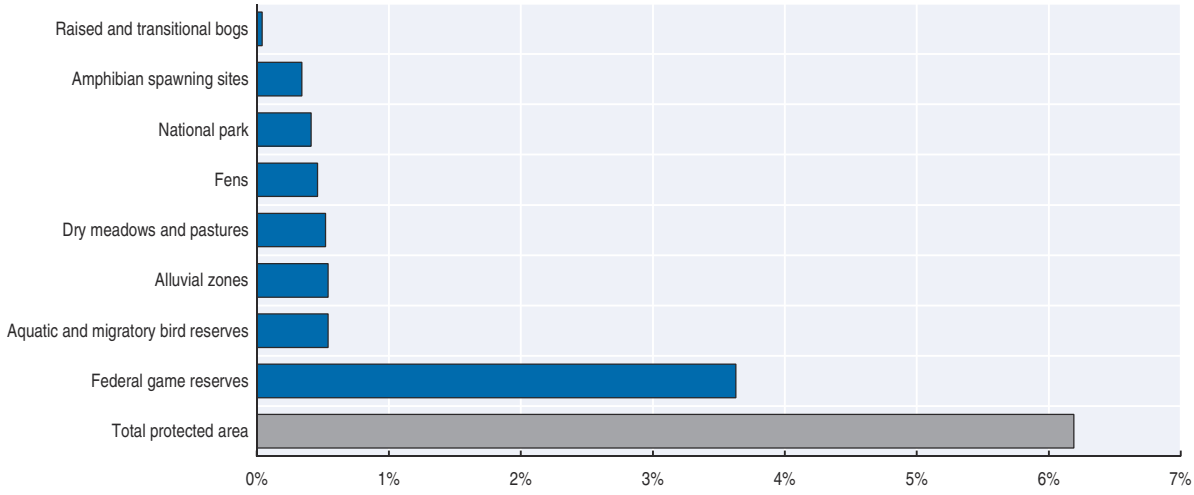
Land use and protected areas

Two-thirds of Switzerland is productive agricultural land and forest (36% and 31%, respectively, according to the last land use survey, in 2004-09). A further 25% consists of

unproductive areas such as rocks and glaciers. The remaining 8% is built-up area, which since 1990 has been expanding by 1% per year (FSO, 2013). New settlements and urban areas were found to have expanded mostly at the expense of agricultural land, which declined by 2% between 1997 and 2009. Over the same period, forest cover grew, mostly in grassland areas such as summer pastures no longer used for dairy farming (Federal Council, 2015).

Areas protected under federal biodiversity conservation law cover only 6.2% of the national territory. The majority of these protected areas are reserves designed for game species conservation (Figure 1.14). Adding areas protected under cantonal and municipal law would bring the figure closer to 12.5% of the territory (Chapter 5). However, the World Wide Fund for Nature warns that many of the protected areas lack funds for effective protection and management (WWF Switzerland, unpublished).

Figure 1.14. **There are few protected areas under federal law**



Note: Total protected area is expressed as percentage of land area without overlaps.
Source: Federal Council (2015), Environment Switzerland 2015.

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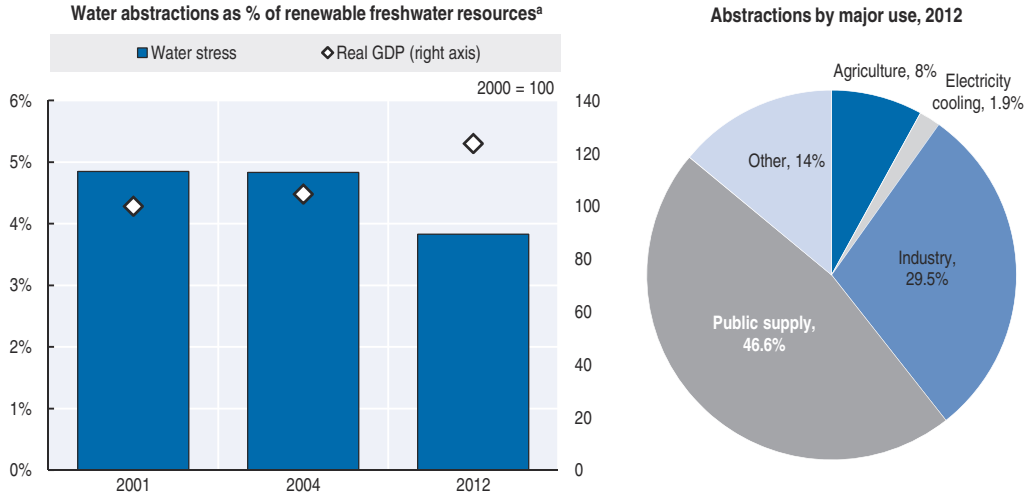
Although Switzerland adopted a biodiversity strategy in April 2012, the development of the final version of the action plan took longer than expected and it was finally released in September 2017 (Chapter 5). A feedback process for stakeholders has been postponed several times, which delayed adoption of the action plan.

5.2. Water

Water quantity

Switzerland is not a water-scarce country, being endowed with some 6 400 m^3 of renewable freshwater resources per capita. It extracts a low share of its available freshwater resources (4%), compared to the averages for OECD Europe (12%) and the OECD (10%). Over the last decade, Switzerland's water abstraction was decoupled from economic growth (Figure 1.15). Studies on the impact of climate change on Switzerland's water resources show that while the country as a whole is likely to continue to be able to cover its water needs, better information collection and collaboration at canton level will be necessary to ensure that water resources are well managed and distributed (Federal Council, 2015). In particular,

Figure 1.15. **Water abstraction is declining**



Note: (a) GDP is expressed in 2010 prices and purchasing power parities. Water stress is defined as total freshwater abstractions as a percentage of total renewable freshwater resources (< 10%: low; 10-20%: moderate; 20-40%: medium-high; > 40%: high).
Source: OECD (2017e), "Freshwater abstractions", *OECD Environment Statistics* (database); OECD (2016a), *OECD National Accounts Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571397

land use intensification – for agriculture and construction of settlements, roads and industrial zones – threatens the protection of groundwater abstraction areas (Chapter 4).

Over time, many watercourses have been altered to meet increasing land and hydropower requirements, with a negative impact on biodiversity. In 2011, amendments to the 1991 Water Protection Act included four measures to restore river ecosystems. As the space reserved for watercourses has narrowed in many places, cantonal land use planning requirements were strengthened to allow the space necessary for natural river functioning. The amendments also provide incentives for rehabilitating 4 000 km of the 15 000 km of dyked watercourses by 2091. Moreover, the law now requires hydropower plant operators to reduce, by 2030, abrupt variations in river flow (hydropeaking) and obstacles to fish migration and sediment transport resulting from hydropower production. In addition, as hydropower production can result in insufficient residual water volumes, with a negative impact on biodiversity, the minimum residual flow standards set in 1991 were strengthened in 2011 (Chapter 4).

Water quality

Water quality in Switzerland has a mixed record: nutrient loads have been reduced overall but not everywhere, and micro-pollutants are an emerging concern, as is biological status. The construction of sewage treatment plants considerably reduced pollution in rivers and lakes. However, organic micro-pollutants are a rising challenge. These come mainly from agricultural pesticides but also from household personal care and cleaning products, as well as medication. Switzerland plans to manage the risks associated with micro-pollutants in urban sewage (by 2040) and pesticide use in agriculture (within ten years of the adoption of an action plan). To these ends, it is upgrading the 120 largest plants, accounting for 50% of treated sewage, to add a fourth treatment stage removing micro-pollutants. A pesticide licensing programme is in place to ensure that toxicity does not exceed certain risk

thresholds, and the government is developing an action plan to reduce pesticide risk and encourage sustainable use (Chapter 4).

Switzerland also faces a challenge regarding nitrate concentrations in groundwater. The concentrations exceed the legal limit value of 25 mg/litre at around 25% of monitoring sites. As a preventive measure, cantons must designate groundwater protection zones around wells used for drinking water (Federal Council, 2015).

Recommendations on air, waste, environmental health and information

Air management

- Further reduce levels and deposition of acidifying, eutrophying and ground-level ozone air pollution below critical loads and levels as set out by the Convention on Long-range Transboundary Air Pollution; to that end, set more stringent emission reduction commitments for ammonia, ozone precursors (nitrogen oxides, volatile organic compounds and methane), sulphur oxides and fine particulate matter (e.g. following the example of EU Directive 2016/2284 for the period beyond 2020) and achieve them in accordance with the polluter-pays principle while ensuring coherence with existing instruments (e.g. instruments to reduce agricultural nitrogen surpluses, EURO standards for vehicles, VOC tax for solvents).
- Implement further measures to combat ground-level ozone in Ticino canton, including via more targeted and time-limited measures during the summer.

Waste management

- Prepare a federal waste prevention strategy including indicative targets for municipal waste reduction.
- Consider developing a national resource efficiency strategy to tackle the issue of high DMC levels; in particular, further improve recycling and material recovery of construction and demolition waste by assessing the cost-effectiveness of introducing measures such as extended producer responsibility requirements for construction materials similar to those in Germany, a tax on virgin materials extracted in Switzerland (e.g. gravel, sand) drawing on experiences in Sweden, Denmark and the United Kingdom, and a target for the use of recycled building materials.

Environmental health and information

- Consider developing a new NEHAP with a view to cost-effectively tackling remaining health effects of pollution.
- Strengthen efforts to raise public awareness and avoid public misperception of the state of the environment and of the risks facing Swiss ecosystems; to that end, develop public communication campaigns and foster environmental education at the federal and cantonal levels, and promote local awareness-raising approaches (e.g. as part of Local Agenda 21 and Agenda 2030 for Sustainable Development).

Notes

1. In the past, Switzerland produced a small amount of natural gas.
2. Launched in 1991 by the Swiss Federal Office of Energy, SwissEnergy fosters voluntary initiatives (e.g. through partnerships) to improve energy efficiency and the use of renewables.
3. Sankt Gallen was the first city to introduce the fee, in 1975.

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PART I

Chapter 2

Environmental governance and management

This chapter assesses progress in environmental governance and management since the last OECD Environmental Performance Review. *It provides an overview of the institutional framework for environmental management, touching upon horizontal and vertical co-ordination mechanisms. It discusses the regulatory framework, including key developments in specific areas such as air quality and waste management, and examines the Swiss approach to environmental permitting, compliance and enforcement. Finally, it discusses environmental democracy, from public participation to access to justice and information.*

1. Introduction

The specificity of environmental governance in Switzerland as a federal country is that the Confederation establishes the overarching legal framework that is implemented by cantons and municipalities. This system is based on the legal principles of subsidiarity and co-operation. The former implies that the federal authorities intervene only if they can ensure more effective action than cantonal or municipal authorities, while the latter calls for close collaboration among the levels of government and stakeholders. Cantons and municipalities have a large degree of autonomy in implementing and enforcing federal environmental legislation, which leads to significant differences in the way they carry out their tasks. The Confederation's oversight over cantons, using performance measurement and reporting, could be strengthened to ensure a level playing field in the implementation of environmental law.

Switzerland co-operates with the European Union (EU) in many areas related to environmental protection, including agriculture and public procurement. Although it has not joined the European Economic Area, Switzerland is progressively moving its environmental law closer to the EU acquis. Since the 2007 Environmental Performance Review (EPR), Switzerland has made significant progress, especially in the area of environmental democracy. This was mainly achieved through ratification of the Aarhus Convention in 2014, which strengthened the role of public participation and the country's position on access to environmental information and justice. In addition, Switzerland has actively been developing and modernising its environmental laws through recent amendments to the Environmental Protection Act, the Waters Protection Act and the Spatial Planning Act. More efforts are still needed on strengthening vertical co-ordination and integrated permitting.

2. Institutional framework for environmental governance

Swiss environmental policy plays out at three levels: the Confederation, cantons and municipalities. The cantons have a high degree of autonomy on regulating and implementing environmental policy, in accordance with the principle of subsidiarity and pursuant to federal legislation and guidelines. This means the federal authorities do not interfere with cantonal governance (except on matters for which the Confederation has sole responsibility[1]) unless federal action would be more effective than cantonal or municipal action.

EU environmental regulations do not directly apply to Switzerland, as the country is not a member of the EU or the European Economic Area, whose non-EU members have agreed to align their environmental legislation with the EU acquis. Switzerland is, however, a member of the European Free Trade Association and has established bilateral agreements with the EU in various areas, covering for instance agriculture, public procurement, and air and road traffic. In that context, the country integrates certain aspects of EU legislation into national legislation, while retaining its prerogatives on environmental policy. Switzerland is a member of the European Environment Agency and is involved in its work (Box 2.1). The

Box 2.1. **Major Swiss-EU bilateral agreements**

The first bilateral agreements between Switzerland and the EU date back to the 1970s and were mainly about mutual market access. Another round of accords was negotiated in 1999 and included agreements on public procurement and agriculture to facilitate Swiss-EU trade. In addition, two agreements on air and road traffic dealt with opening the transport market but also contributed to the shift of transalpine freight traffic from road to rail and introduced a heavy vehicles tax, thus promoting environment-friendly measures.

A third round of bilateral agreements from 2004 contains an environmental chapter, which governs Switzerland's participation in the European Environment Agency. This entails access to a Europe-wide environment database, participation in the organisation of projects and research activities, and better comparability and harmonisation of Switzerland's activities with those of neighbouring countries through exchange of information.

Source: FDFA (2017), *Bilateral agreements*, *www.fdfa.admin.ch/dea/en/home/bilaterale-abkommen/abkommen-umsetzung/abkommenstexte.html*.

country also participates in the European Network of the Heads of Environment Protection Agencies and the network of Heads of European Nature Conservation Agencies.

Under the Federal Constitution, each of the 26 cantons[2] has its constitution and laws, which must be compatible with those of the Confederation. Cantons also have their own parliaments, governments and courts. Cantons have sole responsibility for implementing environmental policy on most issues, though they share implementation with the federal government on the buildings programme, which aims to improve energy efficiency in buildings (Chapter 3) (FOEN, 2017). Cantons often delegate water supply and sanitation, municipal waste management and local public transport to large municipalities. Small municipalities, especially in rural areas, may lack the capacity to carry out such tasks, which are then undertaken by the canton. Most cantons have an intermediate level of government, the district, responsible mostly for judicial matters. In addition, some forest agencies are at the district level.

Switzerland has 2 325 municipalities (FSO, 2016a). Around one-fifth are cities or large towns, which have elected councils. Smaller municipalities reach decisions via a communal assembly, in which all residents who are entitled to vote can participate. The degree of municipal autonomy varies considerably. Generally, municipalities have direct responsibilities in local planning and local taxation (property tax, rent tax and charges on waste, water and sanitation) (Petitpierre, 2015).

2.1. National institutions and horizontal co-ordination

The Federal Assembly (the Swiss parliament) has two chambers with identical powers. The National Council, the lower chamber, represents the populace; the number of deputies sent by each canton depends on the size of its population. The Council of States, the upper chamber, represents the cantons; it comprises two deputies from each canton (including one from each half-canton). Deputies to both chambers are elected directly by Swiss citizens (according to federal and cantonal rules, respectively) and are not bound by instructions from their cantonal government.

The Federal Assembly elects the seven members of the Swiss government, the Federal Council. Each council member heads a federal department. The departments are roughly

equivalent to ministries, but their scope is generally broader than in other OECD countries. Each department consists of several federal offices and specialised agencies.

The Federal Department of the Environment, Transport, Energy and Communications (DETEC) oversees policy making in environmental protection, energy, transport, land use planning and communication via, respectively, the Federal Office for the Environment (FOEN), the Swiss Federal Office of Energy (SFOE), the Federal Office of Transport, the Federal Roads Office, the Federal Office of Civil Aviation, the Federal Office for Spatial Development (ARE) and the Federal Office of Communications. Communication and co-ordination among the four DETEC offices needs to be strengthened.

The Federal Department of Economic Affairs, Education and Research (EAER) includes the Federal Office for Agriculture (FOAG), the State Secretariat for Education, Research and Innovation, and the State Secretariat for Economic Affairs, which oversees issues related to economic and labour market policy. The Federal Department of Finance mainly deals with the state budget and fiscal policy (Petitpierre, 2015).

The Inter-departmental Sustainable Development Committee is the only environment-related inter-ministerial co-operation mechanism. Established in 2004 under the aegis of ARE, it meets regularly to oversee implementation of the Sustainable Development Strategy. Members represent around 35 federal agencies (DETEC, 2016).

2.2. Subnational institutions and vertical co-ordination

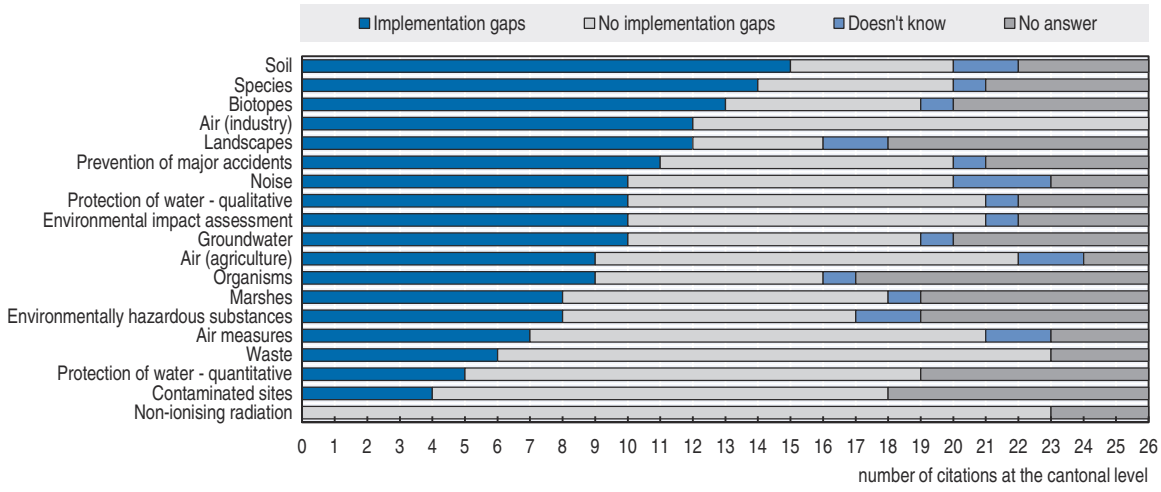
Cantons can enact cantonal environmental legislation pursuant to federal environmental law. They also have key implementation and enforcement responsibilities with regard to federal and cantonal environmental legislation. Each canton has an environment department, whose responsibilities sometimes extend to other sectors, such as transport, land use, agriculture and energy. Cantons vary in how they carry out their tasks, particularly as regards the extent to which they delegate them to municipalities. FOEN supervises cantonal implementation of federal law to ensure that it is uniform throughout the country. However, there are no formal oversight procedures, systematic evaluation or indicators of cantonal performance. This lack of feedback is a major impediment to reform of federal environmental policy.

Developing cantonal environmental performance indicators and using them for regular reporting to the Confederation would contribute to more consistent nationwide implementation of environmental law. The US Environmental Protection Agency, for example, has developed a compliance assurance review framework to ensure a level playing field across states and thus limit federal intervention. The review is conducted at least every four years and the framework is based on a dozen core indicators covering compliance monitoring, civil enforcement and data management (Mazur, 2011).

The 2007 EPR recommended enhanced co-ordination between cantons and the Confederation. In 2013, a FOEN-commissioned study of implementation gaps in environmental law confirmed that some were due to a lack of such co-operation. Survey data from the 26 cantons revealed that key implementation issues were related to biodiversity, landscape protection and related land use (Figure 2.1). It should be noted, in connection with this, that Switzerland has recently adopted the action plan of its 2012 biodiversity strategy under the Convention on Biological Diversity (Chapter 5). The plan will define institutional responsibilities and measures to ensure that biodiversity objectives are met.

The 2013 study recommended increased monitoring by the Confederation, exchange of best practices and the establishment of institutional mechanisms to strengthen

Figure 2.1. **Biodiversity implementation gaps are particularly significant**



Source: FOEN (2013b), Strengthening Environmental Enforcement.

StatLink http://dx.doi.org/10.1787/888933571416

collaboration among cantons. However, the next steps were not clearly identified (FOEN, 2013b). Switzerland should ensure that all necessary measures, supported by sufficient resources, are in place to implement these recommendations.

Instead of a formal reporting mechanism to ensure federal-cantonal co-ordination, Switzerland relies on soft mechanisms to facilitate information exchange and capacity building. For example, FOEN is a permanent invitee to the Conference of Heads of Environmental Protection Services (CCE), made up of the heads of the cantons' environment departments. The CCE's mandate is confined to developing guidance documents on various environmental issues. It has regional working groups on the main environmental issues, such as air, waste, contaminated sites, ecosystems, biodiversity, water and noise (CCE, 2016). However, not all cantons participate in the working groups, municipalities are not systematically invited and overall co-operation is often complicated by the difference in cantons' approaches to implementation of federal legislation. FOEN thus has a clear explanatory role to play in the CCE meetings, which constitute an essential tool for enhancing vertical co-ordination. Comprehensive coverage of topics and increased cantonal and municipal participation would also help strengthen the CCE's role. Other similar thematic networks include the Conference of the Delegates for Nature and Landscape Conservation, the Conference of Heads of Forestry Services, the Conference of the Directors of Public Works, Land Use and Environment, and the Conference for Forestry, Wildlife and Landscape.

Other vertical co-ordination initiatives include Cercl'Air, an association of some 230 members that brings together the cantonal and federal authorities as well as academics to discuss air quality issues. Similar associations exist for waste, noise, water and land. In addition, the SFOE's SwissEnergy provides a discussion platform on energy efficiency and renewable energy resources to the federal, cantonal and municipal levels as well as the business sector and non-government organisations (NGOs) (SwissEnergy, 2016). Once a year FOEN organises a roundtable in which it invites waste management companies, as well as municipal, cantonal and federal authorities, to discuss measures to tackle the problem of litter (FOEN, 2016b). Roundtables are organised for other environmental issues as well. Switzerland should promote the further development of such initiatives and would

benefit from best practices in OECD countries, some of which have established permanent structures to facilitate vertical collaboration, such as the National Environmental Enforcement Co-operation Secretariat in the Netherlands and Sweden's Enforcement and Regulations Council (Mazur, 2011).

In addition, FOEN provides guidance to cantons through so-called enforcement aids – guidelines on a vast array of environmental topics aimed at harmonising implementation and enforcement of environmental law across the country. These guidelines are extremely useful and well prepared. They enhance the effectiveness of direct regulatory approaches by combining them with an information instrument. Switzerland should pursue the publication of enforcement aids in consultation with cantons, extend their coverage and update existing ones as legislation develops.

Federal-cantonal programme agreements are another form of vertical co-ordination. One such agreement may describe, for example, environmental challenges in a canton and measures to address them. The agreements were introduced in the 2008 fiscal equalisation reform, which established new requisites for federal budgetary transfers to the cantons (FDF, 2007).

In accordance with OECD best practices, municipalities co-operate among themselves via the Association of Swiss Communes and the Swiss Union of Cities. The former includes around 70% of municipalities and promotes co-operation, including in the area of environmental protection; the latter represents Swiss cities in cantonal and federal decision making and develops policy guidance documents for cities. In addition, around 360 towns belong to the Energy City network, aimed at promoting energy efficiency and renewables projects in line with the 2013 federal Energy Strategy 2050 (ASC, 2016; SVC, 2016). This follows a common trend in OECD countries, in which municipal associations are increasingly incorporating environmental considerations in their agendas, thus creating opportunities for strengthening capacity building and economies of scale to develop environmental infrastructure.

3. Regulatory framework

The Constitution (Articles 73 to 80) sets out the main principles of sustainable development, environmental protection, spatial planning, water protection, forest protection, nature conservation, hunting and fishing, and animal welfare. Each principle is developed in the 1983 Environmental Protection Act (EPA), supplemented by other federal acts and ordinances (Table 2.1). The 2011 Act on Reduction of CO_2 Emissions, the heart of Swiss climate policy with its 2012 ordinance, sets an emission reduction target for 2020 and includes instruments to achieve the target in buildings, transport and industry. The main air quality legislation is the 1985 Ordinance on Air Pollution Control (OAPC), which defines limit values for atmospheric pollutants and the design of preventive measures. The latest OAPC amendment, which entered into force in April 2017, softened requirements for wood burning, which is now allowed for heating in small private combustion plants. After Switzerland ratified the Aarhus Convention in 2014, the EPA was amended with provisions on access to environmental information (Petitpierre, 2015).

The legal provisions concerning water are numerous. The 1991 Waters Protection Act (WPA) and a 1998 ordinance lay down the main rules for water quality preservation, outlining protection measures and governing residual flows and sewage treatment. An amendment of the WPA in 2011 regulates hydropower plants in terms of hydropeaking and obstacles to fish

Table 2.1. **Main federal environmental laws**

Acts	Enactment	Latest amendment
Act on Protection of Nature and Cultural Heritage	1966	2014
Spatial Planning Act	1979	2014
Environmental Protection Act	1983	2014
Act on Hunting and Protection of Wild Mammals and Birds	1986	2014
Forest Act	1991	2017
Waters Protection Act	1991	2011
Fishing Act	1991	2013
Chemicals Act	2000	
Act on Reduction of CO_2 Emissions	2011	
Ordinances		
Ordinance on the Federal Inventory of Landscapes and Natural Monuments of National Importance	1977	2010
Ordinance on Air Pollution Control	1985	2017
Ordinance on Hunting and Protection of Mammals and Wildfowl	1988	
Ordinance on Environmental Impact Assessment	1988	2016
Ordinance on Waste Treatment	1990	2016
Ordinance on Protection of Nature and Cultural Heritage	1991	
Ordinance on Forests	1992	
Ordinance on Water Protection	1998	
Ordinance on Remediation of Polluted Sites	1998	
Ordinance on Land Planning	2000	
Ordinance on the Charge for the Remediation of Contaminated Sites	2008	
Ordinance on Reduction of CO_2 Emissions	2012	

migration and sediment transport; it also goes beyond water quality requirements by recognising the habitat function of rivers and lakes for both flora and fauna (e.g. by allowing sufficient space for rivers and rehabilitating dyked watercourses). More specific laws complement the WPA, including a 1991 watercourse management act that regulates flooding and an act on the granting of water use rights for hydropower. Soil quality is regulated by a 1998 ordinance on damage to soil. Land use planning is covered by the 1979 Spatial Planning Act (SPA) and a 2000 ordinance. The SPA was amended in 2014 to make expansion of building zones conditional upon a projected increase in population (Chapter 4).

The 1966 Act on the Protection of Nature and Cultural Heritage (NCHA) and associated 1991 ordinance aim to protect fauna, flora and both natural and historical landscapes. Special biotopes of national importance, such as wetlands are subject to inventory and their protection is financially supported by the Confederation. The Forest Act and 1992 ordinance provide, among other matters, for prohibition of clearing and of motor vehicle traffic in forests. The Forest Act was amended in 2017 to better protect forests against pests and climate change, allow increased exploitation and use of indigenous wood and improve competitiveness of the forestry sector. The 1986 Act on Hunting and Protection of Wild Mammals and Birds and 1988 ordinance aim at sustainable exploitation of game resources and protection of wildlife. The 1991 Fishing Act aims to protect fish stocks and their natural environment (e.g. by regulating issuance of fishing permits).

The 1990 Waste Treatment Ordinance lays down the main rules for waste collection and disposal (incineration, composting, landfilling). An amendment that entered into force in 2016 focuses on limiting and reducing waste as well as targeted recycling; it was later renamed the Ordinance on Waste Limitation and Disposal. The 2000 Ordinance on Beverage Containers aims primarily at recycling of glass and PET packaging. The 1998 Ordinance on

the Return, Take-back and Disposal of Electrical and Electronic Equipment introduces a prepaid disposal tax as well as extended producer responsibility (obliging merchants to take back used equipment free of charge). The 1998 Ordinance on Remediation of Polluted Sites focuses on former landfills and provides for the establishment of a cadastre of polluted sites.

The 2000 Act on Protection against Dangerous Substances and Preparations (Chemicals Act) aims to prevent harmful health and environmental effects of chemical substances. The act also covers the use of microorganisms for biocidal or phytosanitary purposes.

3.1. Evaluation of policies and regulations

Switzerland makes use of several *ex ante* environmental evaluation tools. In 2007 FOEN developed a manual on how to carry out economic assessment (known by the German acronym VOBU) of environmental policies and legislation at all levels of government. VOBUs aim to improve cost-efficiency and effectiveness of environmental policy and enhance transparency about the economic benefits of environmental protection. FOEN had already been assessing the economic effects of environmental measures on an ad hoc basis, but since 2007 VOBUs have been systematically used. Over the review period, almost 70 VOBUs were undertaken on a wide array of bills, plans and policies, including on CO_2 emissions, micro-pollutants, biodiversity, waste and green economy. Their findings led to re-examination of objectives and better evaluation of alternatives. In 2016, the results of a VOBU on climate policy informed amendment of the CO_2 law, especially with regard to the economic impact on businesses, households and the public sector. The distributional impact of the CO_2 tax was also considered.

The systematic use of VOBUs for evaluating environmental policies is commendable. A critical view, however, should be taken with regard to the overlapping of *ex ante* evaluations in Switzerland. First, VOBUs duplicates energy impact assessments (known by the German acronym EFS), which aim to improve the energy efficiency of planned regulation. Second, the VOBU manual duplicates to some extent the guidelines on federal regulatory impact assessment (RIA), which is mandatory for all new legislation and may include environmental considerations, though the main focus is the overall national economy. Third, Switzerland also carries out sustainability assessment (SA) of draft regulations, which addresses the three pillars of sustainable development (economic, social and environmental). SA is mandatory in agriculture and transport (Jakob et al., 2011). Such overlaps led the Federal Audit Office to ask the administration to ensure consistency between the VOBU manual and the RIA and SA procedures (SECO, 2016).

Contrary to common EU practice, Switzerland has not introduced strategic environmental assessment (SEA) requirements at the national level. In 2008 the Federal Council proposed amending the EPA and SPA to include elements of SEA so as to improve co-ordination between environmental protection and spatial planning. To this end, the council requested FOEN and ARE to publish implementation guidelines and studies. FOEN and ARE released a guidance document in 2012 aimed at helping cantons develop *ex ante* evaluations on environment, health and sustainable development issues when designing land use plans. This was followed in 2014 by a study on SEA recommending that Switzerland introduce it in the EPA and SPA, and proposing that it include a screening procedure, analysis of alternatives, a strong participatory process and monitoring. The study concluded that voluntary SEA, as conducted in Vaud canton, could be a first step in introduction of SEA at

the federal level and contribute to its acceptance by public authorities, as has happened in Geneva canton (Box 2.2). FOEN is updating the 2014 study, and including examples and frequently asked questions on SEA, to further raise awareness on the instrument.

Box 2.2. **Two cantons apply SEA in spatial planning**

Geneva is the only canton that has made SEA of cantonal spatial planning (structure plans and land use plans) compulsory. The legal basis is laid down in the cantonal regulation transposing the federal ordinance on environmental impact assessment. SEA has to be conducted under the supervision of the canton's environmental department and must include a solid analysis of alternatives. SEA is limited to spatial planning; it does not cover other plans and programmes likely to have an environmental impact. A certain level of flexibility is allowed in the development of SEA. The canton does not issue stringent methodological requirements, but publishes a guidance document to inform preparation of local land use plans.

In addition, since 2006 SEA of cantonal spatial planning has been carried out on a voluntary basis in the Vaud canton. SEA is not anchored in cantonal law and no guidance document is available; instead the procedure is individual, with oversight responsibility assigned to the cantonal environmental department. As in Geneva, the scope of SEA is confined to spatial planning.

Source: FOEN (2016c), *Evaluation environnementale stratégique (Strategic Environmental Assessment)*, *www.bafu.admin.ch/bafu/fr/home/themes/eie/evaluation-environnementale-strategique--ees-.html*.

The 2007 EPR recommended that environmental assessment be improved in transport, the energy sectors and land use planning. It noted that Switzerland had not ratified the 2003 United Nations Economic Commission for Europe (UNECE) SEA protocol to the Espoo Convention on Environmental Impact Assessment in a Transboundary Context. There are plans to include elements of SEA (as a so-called efficiency evaluation strategy) in assessment of cantonal land use plans so as to better integrate environmental considerations into spatial planning. However, despite FOEN's support of the initiative, it seems unlikely that the parliament will be willing to amend the SPA and EPA so soon after their latest update in 2014. Switzerland should support a prompt introduction of SEA requirements at the federal level. It should also consider ratifying the UNECE protocol on SEA.

Ex post evaluations of environmental law are not conducted systematically. Recent *ex post* evaluations were carried out on the CO_2 tax in 2015 and on the federal and cantonal buildings programme in 2016. The Federal Office of Justice convenes a roundtable of federal officials to evaluate selected topics three times a year; the last environment-related discussion was held in 2001, when nature and landscape were examined (FOJ, 2016).

3.2. Environmental standards

This section provides a brief overview of environmental standards related to air quality and waste management. The EPA sets national-level standards, which cantons are expected to comply with or surpass. Cantons may set stricter emission standards to address local air pollution hotspots. Direct regulatory instruments for water quality and biodiversity are addressed in Chapters 4 and 5, respectively.

Air quality

The OAPC sets air quality standards (emission limits) for conventional pollutants such as sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ground-level ozone (O_3) and particles (PM_{10}) as well as for toxic contaminants such as heavy metals. The Swiss air quality standards are generally but not always in line with the World Health Organization recommended limits. They are stricter for NO_2 and O_3 but less stringent for the daily mean of SO_2. Emission standards are established for a range of organic and inorganic substances and carcinogens[3] for both stationary and mobile sources. New and existing installations are subject to the same emission standards. However, existing installations are given a grace period (usually five years, up to ten in exceptional circumstances) to comply with new standards.

Operators of stationary sources are required to provide cantons with information on the type and level of emissions as part of routine self-monitoring and reporting (Romy and Dürig, 2015). Where ambient air quality standards are exceeded (pollution hotspots), the canton must draw up a five-year action plan indicating the sources of emissions, measures to reduce them, deadlines and the enforcement authority responsible. Where it is expected that action plan targets will not be met, the canton is entitled to set more stringent standards for major emission sources for the duration of the plan (Petitpierre, 2015).

Waste management

The EPA sets out a hierarchy for municipal solid waste (MSW) management: prevention, reuse, recycling, safe disposal. Cantons are in charge of waste management planning while municipalities are responsible for collection and disposal of non-hazardous MSW. Waste management plans regulate the number, location and type of waste treatment and disposal facilities, whose licensing is the responsibility of cantons.

The EPA also covers special (hazardous) waste, which is defined in line with the EU hazardous waste directive (91/689/EEC). The federal ordinance on hazardous waste movements establishes a licensing system, under FOEN, for domestic and international transfers of hazardous waste; the system is compliant with the Basel Convention on the control of international movements of hazardous waste and its disposal (Petitpierre, 2015).

3.3. Environmental impact assessment and permitting

Environmental impact assessment (EIA) is required for projects that are likely to have a significant impact on the environment. The legal basis is in the EPA and its 1988 EIA ordinance, which details the types of projects that are subject to EIA; these include transport infrastructure, power and industrial plants, refineries and waste facilities. Most EIAs are the sole responsibility of cantons. Some, such as major energy projects or forestry projects of more than 0.5 hectare, require FOEN oversight.

An initial screening by cantonal or federal authorities (depending on the case) determines whether a project poses a risk of environmental harm. If it does, the applicant is required to submit an environmental impact report to the relevant authority. This report and authorities' draft evaluation must be made available to the public for consultation for about 30 days (it varies by canton). Finally, the decision to authorise a project or not is published in the official journal. The decision is an integral part of the procedure to obtain a construction permit (Petitpierre, 2015; FOEN, 2013a).

Switzerland lacks integrated permitting, in contrast with EU practice (Industrial Emissions Directive, 2010/75/EU), as the 2007 EPR pointed out. Instead, most cantons issue

operating permits that cover specific environmental issues, such as air, water, waste and noise. EU integrated permits usually apply to high-risk installations and cover pollution releases to air, water and land; waste generation; raw material use; energy efficiency; noise; accident prevention; and site restoration after closure. Conditions are based on best available techniques. For facilities with lower environmental risk (most of which are small and medium-sized enterprises, SMEs), many EU countries have introduced simplified permitting based on binding sector-specific criteria, which entail a lower administrative burden both on the regulator and facility operators (Mazur, 2011) (Box 2.3).

Box 2.3. **General binding rules in selected OECD countries**

The following three criteria are generally applied when designing general binding rules (GBRs):

- There has to be enough regulated entities in a sector to ensure the effectiveness of GBRs.
- The state of technology and techniques in the sector must not be so fast moving that rules cannot be updated frequently enough.
- Facilities must have similar, low-risk environmental impact.

The Netherlands has differing requirements for three categories of installations: facilities characterised by minimal impact are regulated by general provisions, with no need to notify the authority responsible; installations that have a moderate impact are covered by activity-specific GBRs and have to notify the authority; and installations with potentially large impact must obtain an environmental licence in line with activity-specific GBRs. Dutch GBRs establish provisions both quantitative (emission limit values) and qualitative (specific techniques or management practices). They cover about 40 000 companies engaged in activities related to hazardous substances, plastics, metals, paper and textiles, food products, vehicles and other motorised equipment, and other sectors.

In the United Kingdom, the system takes the form of exemption from permitting with no mandatory notification to environment authorities. In France, installations under the so-called *déclaration* regime are subject to GBRs that are laid out in standardised ministerial orders and included in a declaration sent by the prefect to the operator. As inspection services do not usually review declarations, environmental authorities often lack knowledge of low-risk installations. Some US states address a similar issue by requiring operators to regularly report GBR compliance to the relevant authority.

Source: Mazur (2012), "Green Transformation of Small Businesses: Achieving and Going Beyond Environmental Requirements", *http://dx.doi.org/10.1787/5k92r8nmfgxp-en*.

The SPA requires a building permit for any new construction or alteration of existing buildings. Except national infrastructure projects, for which the permitting responsibility is assigned to the Confederation in consultation with cantons and the public, building permits are usually issued by the municipality where the construction work is planned, in line with the municipal master plan (Section 3.4). However, cantons vary widely in their environmental requirements for permits. These requirements, such as noise pollution standards, do not always take into account the whole environmental performance of the installation. Moreover, this approach does not differentiate requirements based on the relative environmental risk of an installation.

3.4. Land use planning

Awareness grew in the 2000s of the need to better manage scarce soil resources in a context of demographic and economic growth. In response, DETEC, the Conference of Cantonal Governments, the Conference of Cantonal Directors of Public Works, Spatial Planning and Environment, the Union of Swiss Cities and the Association of Swiss Municipalities agreed in 2006 to draw up a Swiss Territory Project (STP) under the aegis of ARE.

The project is intended to serve as a decision-making aid for activities with territorial impact at the three administrative levels. It is voluntary rather than legally binding from a legal point of view but calls for a voluntary approach. There are three complementary strategies aimed at achieving the objectives of the STP: a) delimiting territories for action, b) making moderate use of the soil by densifying the built environment while taking account of landscapes, and c) improving co-ordination of transport, energy and territorial development (CdC, 2012).

The SPA provides the legal framework and overarching principles for spatial planning and sets out the responsibilities of the Confederation, cantons and municipalities. At the national level, a non-binding countrywide strategic plan, five sector plans and two spatial concepts exist. The sector plans concern agricultural areas, transport networks, energy infrastructure, nuclear waste sites and military areas. They designate specific land use areas and are binding for subordinate plans. The spatial concepts, less specific than the sector plans, deal with landscape and sport facility planning (OECD, 2017).

Cantons are responsible for developing structure plans (i.e. master plans) under the SPA. The plans, produced in consultation with municipalities and the public, are approved by the federal government. Updated every ten years, they include public transport networks, nature conservation areas of cantonal importance and waste disposal sites. The plans are binding on the authorities; depending on the state of planning work, their information may range from orientation or interim results to firm statements. The cantonal structure plan is thus a process plan for co-ordinating and steering the next stages of spatial development already under way. Cantons are also charged with issuing land use plans containing binding provisions on how land may be used. Most cantons delegate this task to the municipalities. Many cantons, however, also provide cantonal land use plans for projects of importance for spatial planning policy, such as industrial zones and waste disposal sites. Land use planning involves the important task of setting the boundary between building zones and non-building zones, in which designation of protected areas based on landscape planning is generally imperative (VLP-ASPAN, 2012).

Large cantons often commission public-law agencies called regional planning associations to prepare their spatial planning. In Zürich canton, for example, such associations draw up regional structure plans based on the structure plan for the canton. In Aargau and Thurgau cantons, associations produce basic planning studies and provide municipalities with spatial planning support (VLP-ASPAN, 2012).

However, the lack of a guidance document to help cantons implement the SPA has contributed to a large degree of disparity in implementation of structure plans and land use plans. In addition, large cantons have more extensive and complex land use regulations than small, rural cantons. There is public debate on whether to introduce systematic "efficiency evaluation" of cantonal land use plans, which would include elements of SEA as is already the case in Geneva and Vaud cantons (Box 2.2). This would mean getting the parliament to amend the EPA and SPA (Section 3.1).

4. Compliance assurance

Compliance assurance covers compliance promotion, monitoring and enforcement, as well as liability for environmental damage. Switzerland is a member of IMPEL, the European Union Network for the Implementation and Enforcement of Environmental Law, which aims to share good practices in the application of environmental legislation.

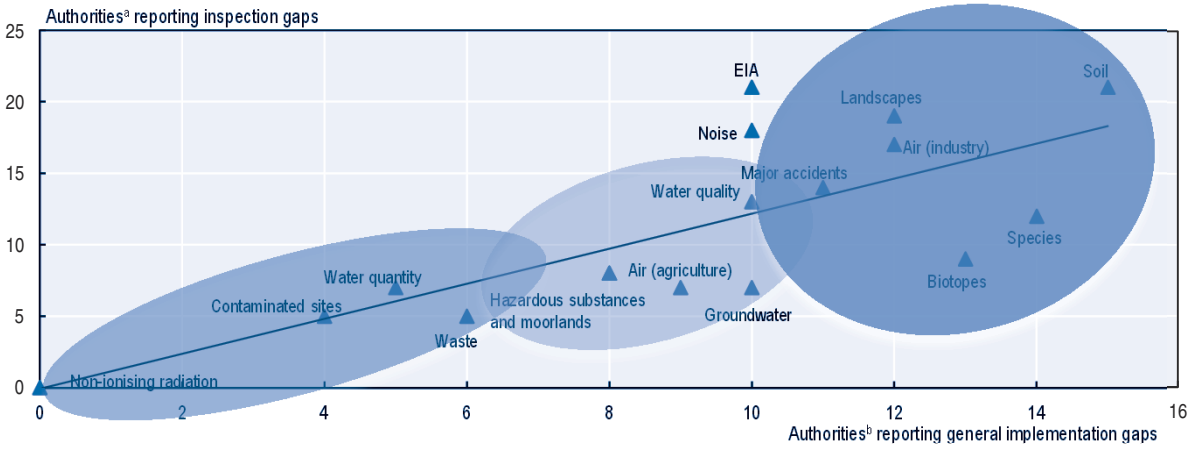
4.1. Inspections

Cantons are in charge of inspecting for compliance with environmental law; they can decide how to carry out inspections, sometimes in co-operation with municipalities. There are no specialised environmental inspectorates at the cantonal level; instead, all non-administrative officials of cantonal environment departments have inspection powers.

For air emission sources, the OAPC mandates routine inspections carried out at least every two years for large combustion plants and every three years for other installations. For installations with emissions above a certain threshold, authorities can order more frequent inspections. The WPA requires regular inspections of sewage treatment plants and manure storage facilities, though their frequency is up to the cantons. In Lucerne canton, for example, industrial sewage discharges are inspected every three to five years for high-risk installations, while low-risk ones are almost never inspected due to resource constraints. Unplanned inspections triggered by accidents, violations or formal complaints are usually conducted by cantonal authorities. In 2016 around 60% of inspections were triggered by accidents. This is a high share by international standards and demonstrates insufficient risk-based targeting of compliance monitoring.

Cantons do not evaluate compliance assurance outcomes (i.e. whether regulated entities have taken measures to ensure that provisions of environmental law are being met), which further impairs inspection planning. The 2013 FOEN-commissioned study on implementation gaps (Section 2.2) showed that insufficient compliance assurance monitoring was a major challenge in implementation of environmental law. Surveys conducted for the study confirmed a direct correlation between the status of implementation and the inspection gaps (Figure 2.2) (FOEN, 2013b). The main reason given for the inspection gaps was resource

Figure 2.2. **Implementation gaps are directly related to the shortage of inspections**



Note: (a) Federal, cantonal, municipal. (b) Cantonal.
Source: FOEN (2013b), Strengthening Environmental Enforcement.

StatLink http://dx.doi.org/10.1787/888933571435

constraints. To address such inspection deficits, the study recommended developing synergies in inspection among the cantons (e.g. peer reviews, benchmarking, inspection staff pooling).

Most cantons outsource inspections. In Lucerne, for example, regulated installations must pay directly for subcontracted inspection services (e.g. sampling and measurement). If a violation is detected, it is up to the canton to ensure that the installation rectifies it. In Basel-Land and Basel-Stadt cantons, 80% of on-site inspections for air emissions are undertaken by subcontractors. Another example is the nationwide inspection of dry cleaners and gas stations, which is entrusted to specialised firms to ensure a consistent approach in all cantons. Building on these good practices, Switzerland could consider developing standard procedures for subcontracted inspection services.

As a general rule, inspections are media-specific. For example, cantons have published a guidance document for air emission inspections within Cercl'Air. Lucerne canton has produced its own manual for inspections in the car industry. Switzerland should consider introducing integrated inspections across environmental media to streamline inspection costs and improve compliance monitoring.

4.2. Enforcement

The EPA provides for administrative injunctions and orders of corrective actions (including plant closure in extreme cases) in response to non-compliance. They are issued by cantonal authorities, which are responsible for enforcement except where the federal government has direct powers. Once a violation is determined, the relevant cantonal or federal authority sends a letter prescribing corrective action, which can be followed by a more formal order with a second deadline if non-compliance persists. Administrative fines may be imposed under cantonal law. Both the type of offences involved and amount of fines vary by canton, which industry perceives as unequal treatment across cantons. Switzerland should consider preparing an enforcement aid to harmonise environmental enforcement across the country.

Serious infringements fall under criminal law. For example, negligence leading to a serious environmental accident, illegal release of harmful substances, or breach of licence conditions for transport and disposal of hazardous waste may result in fines of up to CHF 20 000 (around EUR 18 000) and/or up to three years' imprisonment, according to the EPA. In addition, the penal code enables courts to confiscate the profit gained by infringing the law, e.g. money saved by not taking pollution abatement and control measures. In practice, however, not all cantons apply this penalty.

Most cantonal police agencies have an environmental unit, which is in charge of investigating suspected criminal activity. The National Environmental Security Task Force brings together representatives of environmental enforcement authorities, police, customs officials and the judiciary at the federal and cantonal levels. It was established following a 2012 INTERPOL initiative encouraging countries to set up a co-operation mechanism among law enforcement agencies to fight environmental crime more effectively.

Prosecution can be initiated by environment police, federal, cantonal and municipal government authorities, or environmental NGOs that are directly affected by the offence. However, environmental cases must be brought to court by public prosecutors, who often lack environmental expertise, so this has not proven very effective. Forming a specialised body of prosecutors specialised in environment or at least providing environmental

training to public prosecutors would significantly enhance enforcement of environmental law (Petitpierre, 2015).

4.3. *Environmental liability*

Liability for damage to the environment

Environmental liability is regulated by the EPA, which establishes that the owner and operator of a stationary source of pollution are jointly liable for any environmental damage. It is a strict liability system, in which the owner or operator can only be exempted in case of force majeure or if the liability lies with a third party. With respect to past contamination, a provision adopted in 2013 requires the owner or operator to pay an "appropriate" security deposit whose amount varies between 5% and 20% of the expected investigation, remediation and monitoring cost, depending on the canton. Cantons may require operators to take out private liability insurance. If liability cannot be established or the liable entity is unable to pay, the public authority is ultimately responsible for bearing the clean-up cost.

The EPA does not specify the type of damage regulated and thus the scope of liability. The Code of Obligations (general liability law) focuses on health and does not cover environmental damage. An expert commission set up to reform the code proposed expanding its scope to the environment and giving citizens and environmental NGOs the right to claim compensation (Petitpierre, 2015). Enacting such reform would give environmental liability a stronger legal basis than the EPA alone.

The cost of remediating past contamination must be divided among the responsible parties according to their share of the pollution. Strict liability does not apply when pollution occurred prior to acquisition of a facility by an owner who could not have had any knowledge of it (Romy and Dürig, 2016).

Contaminated sites

The EPA requires cantons to draw up a register of contaminated sites and make it available to the public. It also requires remediation of the registered sites. Switzerland has about 38 000 contaminated sites, out of which 15 000 need investigation to assess their environmental impact. It is estimated that only about 4 000 need remediation. The remediation of the severely contaminated sites (e.g. landfills for hazardous waste) was completed in 2017. Most contaminated sites are located on the industrialised Swiss Plateau. The bulk of them are former waste disposal and industrial sites.

The Ordinance on the Remediation of Polluted Sites (1998) established the procedure for investigation, remediation and monitoring of contaminated sites and set soil decontamination standards. The Federal Council may enact regulations on the urgency of remediation work, but there are no remediation programmes for contaminated sites in place at any government level (Petitpierre, 2015). Cantons can request partial repayment (40%) of the remediation costs from the federal government on the basis of the 2008 Ordinance on the Charge for the Remediation of Contaminated Sites, which establishes a special fund financed by a charge on the disposal of Swiss hazardous waste in landfills in Switzerland and abroad.

4.4. *Promotion of compliance and green practices*

A few cantons provide firms with guidance on environmental compliance requirements for specific sectors. For example, Lucerne canton has an online tool for efficient resource use

in the food industry where companies can learn tips, benchmark their performance and calculate their savings potential. The canton also disseminates information on requirements for sewage pretreatment. But this is the exception rather than the rule. Compliance promotion through information measures is not common in Switzerland. While the federal government uses tools to encourage good environmental performance, cantons are only starting to give compliance promotion the attention it deserves. More should be done by cantons on promoting compliance with environmental law, which reduces social costs (by enhancing environmental protection) and regulatory costs (by increasing the efficiency of compliance monitoring and enforcement). Compliance promotion is particularly effective when targeted at the SME community.

Greening public procurement

The 1994 Act on Public Procurement and its 1995 ordinance set environmental requirements on public procurement. A case in point is paper, which must meet environmental criteria for public purchase. A revision of the Public Procurement Act now under way will include sustainability as one of its objectives and will establish criteria related to the production process. The government is also committed to energy-efficient buildings. In addition, there is a knowledge-sharing platform on sustainable public procurement (FDF, 2017; OECD, 2015). FOEN plans to conduct green public procurement (GPP) training for purchasers. All these developments are in line with the OECD acquis on GPP.[4]

However, there is still substantial room for strengthening GPP. Except in the construction sector, where there are recommendations and standards concerning green and sustainable buildings, Switzerland has no overarching policy framework that pulls its GPP initiatives together. It also lacks GPP targets and definitions of what counts as "green" or "sustainable". Setting GPP targets would boost the market for eco-labelled products (Chapter 3). Switzerland also needs a process to monitor trends in GPP. The fact that most public procurement is done by cantons and municipalities makes GPP monitoring more complicated, as each canton or municipality may take a different approach (OECD, 2015). This reinforces the need for an overarching GPP policy framework.

Corporate environmental management

The "co-operation principle" embodied in the EPA (Article 41a) promotes close collaboration among government levels and between them and stakeholders when implementing regulation. This includes the use of voluntary programmes to achieve environmental goals (Petitpierre, 2015). The 2013 Green Economy Action Plan and its update in 2016-19 also aim to provide targeted measures supporting voluntary commitments by business, science and society to conserve natural resources. A government web portal, Green Economy Dialogue, was set up in 2015 to share information and spur innovative practices on efficient natural resource use (Green Economy Dialogue, 2016). In line with measure 11 of the action plan, the Federal Council in 2014 founded an expert network, Swiss Network for Resource Efficiency (Reffnet.ch), to promote corporate resource efficiency in non-energy sectors. Close to 200 firms, primarily SMEs, voluntarily use its advisory services (Chapter 3).

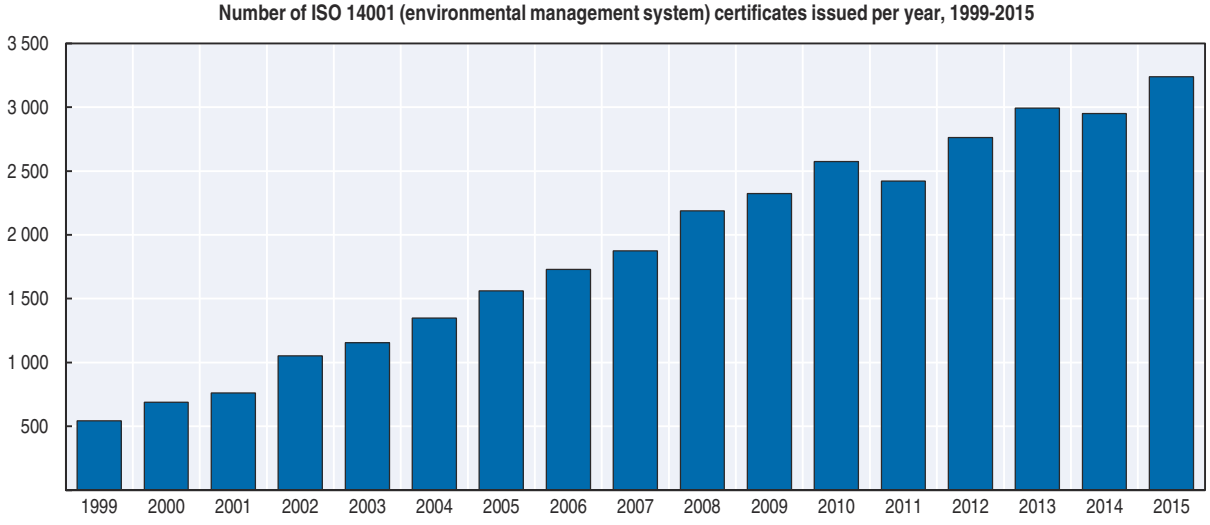
Most voluntary agreements between industry and cantonal authorities seek to meet cantonal energy efficiency targets. The Energy Agency for Economy (EnAW) and the Swiss Cleantech Agency (ACT) provide audits to firms, on request, to help them prepare voluntary agreements. EnAW was created by industry in 2001 to help members set energy efficiency and CO_2 reduction targets. ACT was mandated in 2009 by the Confederation to facilitate

application of climate and energy legislation. SMEs can get financial support from the Foundation for Climate Protection and Carbon Offset (known by the German acronym KliK) to undertake such audits (Petitpierre, 2015). KliK was established in 2012 by the Swiss oil industry to offset CO_2 emissions in countries producing Swiss imports of road fuels by supporting greenhouse gas reduction projects in Switzerland (Chapter 3).

Voluntary programmes are also used in combination with market-based instruments. For example, the Swiss Association of Waste Treatment Facility Operators has put forward a proposal for its members to reduce CO_2 emissions from waste incineration by 200 000 tonnes by 2020 compared to the 2010 levels. Facilities that participate would be exempt from participation in the Swiss GHG emission trading system.

Adoption of environmental management systems by Swiss businesses has been growing rapidly despite the absence of policy incentives (e.g. lower permitting fees, less frequent inspections, reduced fines) for ISO 14 001 certification. The number of certified businesses increased more than six fold over 1999-2015, a rise driven solely by market demand (Figure 2.3).

Figure 2.3. **More businesses voluntarily adopt environmental management systems**



Source: ISO (2016), "Switzerland".

StatLink http://dx.doi.org/10.1787/888933571454

5. Promoting environmental democracy

As the 2007 EPR recommended, in 2014 Switzerland ratified the UNECE Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention). This strengthened the country's legislation and practices on access to environmental information, public participation in decision-making processes related to environmental issues, and access to justice on environmental matters.

5.1. *Public participation in environmental decision making*

Switzerland has a long tradition of involving the public in environmental decision making. Citizens are called upon to vote on popular initiatives, optional referendums or mandatory referendums. Referendums are mandatory for any proposed amendment to the Constitution. Each citizen has the right to launch an optional referendum against a law

proposed by the parliament if it collects 50 000 signatures within 100 days of the bill's official publication. For example, a proposed amendment of the Energy Act was approved on 21 May 2017 following an optional referendum (Chapter 3). In such cases, only a majority of the Swiss electorate is required for approval (the cantons are not consulted). Citizens may also call for referendums through a popular initiative (often followed by a government counter-proposal). Launching a popular initiative requires collecting supporting signatures from 100 000 voters. To be approved, popular initiatives require not only a majority of the electorate but also a majority of cantons. For example, the Water Protection Act was amended in 2011 following a 2006 popular initiative on living waters, which had been withdrawn following a counter-proposal by the government (Chapter 4). Since 2000, nearly 20 referendums and popular initiatives have focused on environmental issues, though few have been approved (Box 2.4). Even when refused, they can nevertheless help strengthen environmental policies by engaging citizens in public environmental debate and exerting pressure on the government. EIA approval is also subject to broad public participation (Section 3.3), as is the development of cantonal structure plans and land use plans (Section 3.4).

Box 2.4. **Most referendums and popular initiatives on environmental issues fail to get support**

Since 2000, Swiss voters have approved only six referendums and popular initiatives on environmental matters, including one popular initiative (Table 2.2). While this key instrument of Swiss direct democracy has proved effective in engaging the population and influencing the legislative process, environmental referendums have often represented missed opportunities to improve environmental policies.

Table 2.2. **Swiss referendums and popular initiatives on environmental issues**

Year	Question	Result
2001	Popular initiative: taxing energy not labour	Rejected
2002	Electricity market liberalisation	Rejected
2003	Motor-vehicle-free Sundays in cities	Rejected
	Electricity without nuclear power	Rejected
	Ban on new nuclear power plants	Rejected
2005	Popular initiative: against genetically modified food	Approved
2006	Living waters	Rejected
2008	Popular initiative: against fighter aircraft noise in tourism areas	Rejected
	Popular initiative: right to appeal by associations	Rejected
2009	Earmark of kerosene tax revenue for airport safety and environmental concerns	Approved
2010	Enhanced animal welfare	Rejected
2012	Popular initiative: building tax for energy efficiency and environmental measures	Rejected
2013	Amendment of Spatial Planning Act	Approved
	Increase in road tax	Rejected
2014	Financing and development of railway infrastructure	Approved
	Popular initiative: population growth and sustainable development	Rejected
2015	Non-renewable energy tax	Rejected
2016	Gotthard road tunnel rebuilding	Approved
	Popular initiative: fair transport financing	Rejected
	Popular initiative: green economy	Rejected
	Accelerated nuclear power phase-out	Rejected
2017	Amendment of Energy Act	Approved

Box 2.4. **Most referendums and popular initiatives on environmental issues fail to get support** *(cont.)*

In May 2017, almost 60% of Swiss voters backed the government's plan to amend the Energy Act and gradually phase out nuclear power. The plan includes a ban on new nuclear plants, increased support to renewable energy and promotion of reduced energy consumption (Chapter 3). The amended law aims at reducing Switzerland's energy-related environmental impact while ensuring energy security. The result is particularly significant in light of the last referendum calling for a phase-out of nuclear energy, in November 2016. That proposal failed on the grounds that it would compromise energy security, yet the vote was regarded as a victory by environmental organisations, which saw it as confirming that a large segment of the population wanted to opt out of nuclear power in the long run.

In September 2016, 64% of the electorate voted against a proposal to foster a green economy. The initiative was launched to boost resource efficiency and move towards a circular economy by requiring the government to introduce new regulations and tax incentives to significantly reduce consumption by 2050. Geneva was the only canton voting in favour of the initiative, which elsewhere was perceived as too ambitious and potentially having a negative impact on competitiveness, growth and employment.

In 2015 a proposal to replace the value-added tax (VAT) with a tax on non-renewable energy forms (oil, gas, coal and uranium) won only 8% of the vote, with the parliament, government and all cantons being against it. The main argument was that VAT revenue was stable and fairly predictable, covering more than a third of all federal spending (CHF 23 billion out of CHF 65 billion), and that creating tax incentives to change energy consumption behaviour, if effective, would generate less revenue.

In 2013, a referendum to amend the SPA was approved. It aimed at limiting urban sprawl over the following 15 years by matching building zones with foreseeable infrastructure needs, and introduced a 20% tax rate on land transactions meant for development.

5.2. Access to environmental information

The government has improved public access to environmental information. In particular, since ratification of the Aarhus Convention in 2014, the EPA has been amended (new Article 10e) to define the type of environmental information federal and cantonal authorities must provide to the public. Although the law addresses national security and commercial confidentiality concerns, withholding information for these reasons can now be challenged in court. More generally, the 2004 Freedom of Information Act gives citizens the right to obtain information held by federal authorities, free of charge. Also, the WPA and the Chemicals Act include a duty to inform the public about risks related to hazardous substances and pathogens.

Ratification of the Aarhus Convention also resulted in the Federal Council being obliged to submit a state of the environment report to the Federal Assembly every four years. The 2015 publication *Environment Switzerland*, available online, was the first issued under the new procedure; FOEN had prepared previous state of the environment reports but did not submit them to the Federal Assembly. The 2015 Federal Council report included 44 environmental indicators, with a particular focus on energy, transport and climate change (Chapter 1) (FSO, 2016b). The report also contributed to meeting the 2007 EPR recommendation calling for systematising the use of environmental indicators.

Large enterprises are required by law to continuously monitor their pollutant releases to air, water and land, and report the results to the European Pollutant Release and Transfer Register. In 2014, 256 facilities took part.

5.3. *Access to justice*

Under Swiss law, citizens and organisations have a right to bring environmental matters before civil or criminal courts, provided they have standing: they can request prosecution or bring suit only if they produce evidence that they are suffering health and environmental damage as well as economic losses. For example, if a municipality wants to sue a firm on nuisance grounds, it has to demonstrate that its territory is directly concerned.

Federal laws usually contain provisions on grounds for appeal and the administrative authority or court concerned. When they do not, the 2005 Act on the Federal Court and the 1968 Federal Administrative Procedure Act set out conditions for judicial and administrative appeals, respectively. Decisions by cantonal authorities may only be appealed in cantonal courts, whose decisions can in certain cases be appealed to the Federal Court (Romy and Dürig, 2016; Petitpierre, 2015).

Most Swiss environmental NGOs, such as Greenpeace, the World Wide Fund for Nature and the Swiss Foundation for Landscape Conservation, have special statutory standing to appeal rulings and decisions of federal and cantonal authorities that fall within the scope of the EPA and NCHA. For the EPA (Article 55), this includes decisions on land use planning, building construction or modification of installations for which EIA is required (Section 3.3). In such cases, NGOs may claim violation of EPA provisions only if they took part in the EIA procedure from the start and filed opposition to the decision before it is handed down (Petitpierre, 2015). Switzerland should consider providing public financial support to help NGOs (instead of non-specialist lawyers) make the case for environmental protection before the courts. New Zealand, for example, has an Environmental Legal Assistance Fund that covers the costs of legal representation for NGOs defending the public interest in environment-related cases.

5.4. *Environmental education*

Environmental education in Switzerland is focused on sustainable development rather than on purely environmental or green growth issues. Over the last decade, significant progress has been made in including sustainability issues in curricula. In 2007, the Confederation and cantons drew up a joint plan to support integration of sustainable development in curricula and teacher training programmes As a result, most primary and secondary schools include some teaching on sustainable development issues, and university pedagogical programmes have training on sustainable development.

Since 2013, the foundation Education21 has co-ordinated and promoted education for sustainable development at the primary and upper secondary levels, taking over from the Foundation for Environmental Education. Education21 acts on behalf of the Swiss Conference of Cantonal Ministers of Education, the federal government and civil society. Financing is guaranteed by contributions from the federal government, the cantons and civil society, as well as funds generated by the foundation itself. Education21 provides pedagogical and financial support to teacher training institutions, NGOs and schools wishing to foster education in sustainability issues (Education21, 2016).

As regards vocational and professional education and training, in recent years environmental aspects have been included more systematically in guidelines on such

education and training for around 1 000 skill types. In addition, training in the fields of protection and sustainable use of natural resources has been reinforced.

In 2016, the Swiss University Conference, a joint undertaking of the cantons and the Confederation for higher education co-ordination and quality control, approved a new funding programme for 2017-20 called "U Change – Student initiatives for sustainable development", replacing the 2013-16 programme "Sustainable Development at Swiss Universities" to finance innovative student projects, inter- and trans-disciplinary courses and research projects on sustainable development.

Recommendations on environmental governance and management

Vertical co-ordination

- Harmonise and strengthen environmental policy and law implementation across cantons by improving vertical co-ordination, promoting regular performance monitoring mechanisms and indicators; continue to disseminate best regulatory practices across cantons.

Regulatory framework

- Consider introducing integrated environmental permits for large industrial installations, based on best available techniques, to move towards a holistic approach to pollution prevention; simplify the regulatory regime for low-risk installations by introducing sector-specific general binding rules.
- Introduce requirements for SEA of plans and programmes; ratify the UNECE protocol on SEA.

Compliance assurance and promotion

- Improve the effectiveness and efficiency of compliance monitoring by strengthening risk-based inspection planning and developing guidelines for specialised inspection services; promote integrated inspections across environmental media.
- Develop federal guidance to cantons on the use of enforcement tools; strengthen sanctions for non-compliance with federal environmental regulations; consider introducing prosecutors specialised in environment or provide environmental training to public prosecutors to facilitate criminal enforcement.
- Improve the system of liability by defining damage to specific environmental media.
- Encourage voluntary compliance and diffusion of green practices among enterprises by providing sector-specific guidance, especially to SMEs, and offering incentives for environmental management system certification; strengthen green public procurement by setting targets and monitoring their achievement.

Notes

1. These include most energy matters, transport and trade of hazardous waste, and strategic infrastructure.
2. Three cantons are subdivided into "half-cantons", which can be considered equivalent to cantons from an administrative point of view.
3. As listed by the Swiss Accident Insurance Fund; includes arsenic, asbestos, benzene, cadmium and its compounds, cobalt, diesel soot and nickel.
4. Recommendation of the Council on Improving the Environmental Performance of Public Procurement [C(2002)3].

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PART I

Chapter 3

Towards green growth

Switzerland's economy is performing well and recovered strongly from the 2007-09 financial crisis. The country has a Green Economy Action Plan and has made progress in greening the economy, as illustrated by its above-average performance on a number of green-growth-related indicators. There are, however, opportunities to do more. This chapter reviews Switzerland's greening efforts and achievements in the areas of taxation and subsidies, public and private investment, innovation, international development and trade.

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.

1. Introduction

Switzerland is a relatively small country in terms of population (around 100th in the world) and area (around 130th) but a top performer in terms of wealth measured as gross domestic product (GDP) per capita (Chapter 1). The economy is performing well and recovered strongly from the 2009 recession thanks to low interest rates, high immigration and strong exports. Recent developments, such as appreciation of the national currency, explain in part the more modest 1.5% average annual GDP growth over 2011-15, on a par with the OECD average (OECD, 2015a).

As with most advanced countries, the Swiss economy is characterised by a predominance of services, with a particularly prominent financial sector, which contributed an estimated 9.3% of GDP in 2015, compared with 7.2% in the United Kingdom and 4.1% in Germany (SIF, 2016). The industrial sector, however, remains strategic and highly competitive in certain key innovation-based sectors, particularly pharmaceuticals, chemicals and wristwatches. Though agriculture represents less than 1% of GDP, it is perceived as an important element in maintaining food security, rural development and landscape protection (Chapter 5). Switzerland has an open economy, with significant volumes of exports, imports and foreign direct investment (FDI) for its size. Trade openness (measured as exports plus imports as a share of GDP) is a noticeably high 120%, up from around 80% through the 1980s and 1990s, with a progressive increase since then.

Switzerland performs significantly better than the OECD and OECD Europe in terms of production-based resource productivity, whether in terms of energy, greenhouse gases (GHGs) or materials (OECD, 2017b). However, as the 2007 Environmental Performance Review (EPR) stressed (OECD, 2007), the country remains among OECD countries with relatively high per capita consumption-based environmental footprints. This is well illustrated by volumes of road transport and municipal solid waste (MSW), which have both risen steadily in line with GDP growth since 2000. Switzerland is the largest producer of MSW per capita in Europe and among the highest per capita consumption-based carbon dioxide (CO_2) emitters in the OECD. Indeed, there is evidence that embodied CO_2 emissions per capita are highly correlated with material living standards (OECD, 2017b).

As a result of the country's relative trade openness, it is estimated that one-half to three-quarters of its environmental impact results from the import of goods and services, particularly in relation to food consumption, housing and household mobility (Frischknecht et al., 2014). Climate change, ocean acidification, nitrogen pollution and biodiversity loss have been identified as the footprint issues of main concern in relation to Swiss consumption patterns (Dao et al., 2015). While it is difficult to assess whether the impact would be any less if the same goods were produced domestically, this situation highlights the need for the green economy strategy to also address international aspects. Particular attention should be paid to addressing the increasing environmental impact of domestic consumption for developing countries. It is in this context that the indicator set identified by Switzerland to report progress against its Green Economy Action Plan (GEAP) (Section 2)

includes absolute environmental footprints in addition to productivity-related metrics (FOEN, 2016a).

While Switzerland has made progress in greening its economy, as illustrated by its above-average performance on some green-growth-related indicators, it has opportunities to do more. It could, in particular, shift to a coherent green tax system (Section 3), including the removal of remaining environmentally harmful subsidies (Section 4); increase the greening of public procurement (Chapter 2) and investment practices in its prominent corporate and financial sector (Section 6); foster eco-innovation (Section 7); and align trade and environmental policies (Section 8).

2. Approach to greening the economy

Acknowledging the need for the economy to move to more sustainable resource consumption, the Federal Council in 2010 mandated the elaboration of a green economy strategy, with particular focus on clean technology innovation, resource efficiency, consumer information on products' environmental impact and an environment-friendly tax system. In 2013, the council adopted the first GEAP; its 2016-19 version remains the centrepiece of the green economy strategy. The GEAP considers that existing policies (energy, climate, spatial planning) already help reduce the economy's environmental impact but that resource efficiency must be improved, especially for raw materials and consumer products (FOEN, 2013; Swiss Confederation, 2016). Green jobs may result from this approach but, in a context of low unemployment, are not targeted per se (FOEN, 2013).

The 2016-19 GEAP confirms a focus on three priority areas: consumption and production, waste and raw materials, and cross-cutting instruments. It contains 27 measures aimed at conserving natural resources, reducing the environmental impact of consumption and moving to a more circular economy. It envisages a key role for voluntary initiatives from businesses, the scientific community and society, with the federal government prepared to correct market failures. This preference for voluntary initiatives and agreements in the context of greening the economy was confirmed by the rejection of more binding commitments by the parliament and the populace.

In December 2015, the Federal Assembly turned down a proposed amendment of the Environmental Protection Act that would have established a framework for promoting ecologically sound consumption patterns, strengthening the circular economy and providing information on resource efficiency. As a result, implementation of the GEAP in 2016-19 pursues the initial (2013) focus on resource efficiency and conservation through the voluntary commitment of actors concerned, e.g. the Green Economy Dialogue bringing together the private sector, non-government organisations (NGOs), science and academia.

In September 2016, the Swiss rejected a popular initiative, "For a sustainable and resource-efficient economy (Green Economy)". It proposed amending the Constitution to include a provision requiring that, by 2050, Switzerland's ecological footprint, when extrapolated to the world population, should not exceed one Earth. This radical initiative not only failed to achieve voter consent, but the Federal Council and parliament were also against it, arguing that the transition to a green economy was a long-term endeavour, which the economy needs time to adapt to gradually.

As a result of these votes, legislation containing extensive and binding green economy measures is very unlikely. The incremental, step-by-step approach currently favoured by the Swiss authorities, the business sector and the public alike can prevent more ambitious and

transformational commitments. For instance, although the GEAP prioritises resource efficiency, Switzerland lacks a dedicated national resource efficiency strategy (EEA, 2016). Such a strategy could be integrated in the next GEAP and contribute to the design of more tangible targets, building on the Recommendation of the OECD Council on Resource Productivity.

The links between the GEAP and other strategic policy processes, such as Energy Strategy 2050 (initiated in 2013, approved in 2017) and four-year Agriculture Policy packages (Chapter 4), should be clarified, similar to the clear links identified with the Sustainable Development Strategy (SDS, launched in 2002, updated in 2016). Energy Strategy 2050 was triggered by the gradual nuclear phase-out proposed in the aftermath of the Fukushima accident and approved by referendum on 21 May 2017. It envisages reduced fossil fuel use, enhanced energy efficiency in buildings and improved fuel efficiency in the passenger car fleet. It included a plan to more closely align energy policy with climate policy by introducing a Climate and Energy Incentive System (known by the German acronym KELS), especially for transport and electricity (SFOE, 2016). Although KELS is unlikely to be pursued as initially expected, this should not prevent Switzerland from implementing green tax reform (Section 3). The SDS 2016-19 covers measures overlapping with the GEAP, Energy Strategy 2050 and the Agriculture Policy packages, including on consumption and production, energy and climate, and natural resources (Federal Council, 2016a). To address these overlaps and clarify responsibilities, it will be crucial to improve co-ordination both within the Department of the Environment, Transport, Energy and Communications (DETEC) and between it and other departments, beyond the standard consultation for proposed new legislation (Chapter 2).

As Switzerland is located in the heart of the European Union (EU), close co-operation with the EU is particularly important for the Swiss economy-environment interface. In 2016, trade with the EU accounted for 54% of exports and 72% of imports. Economic and trade relations with the EU are governed by bilateral agreements. Some have clear environmental policy implications, for instance regarding transport and carbon pricing.

3. Greening the system of taxes and charges

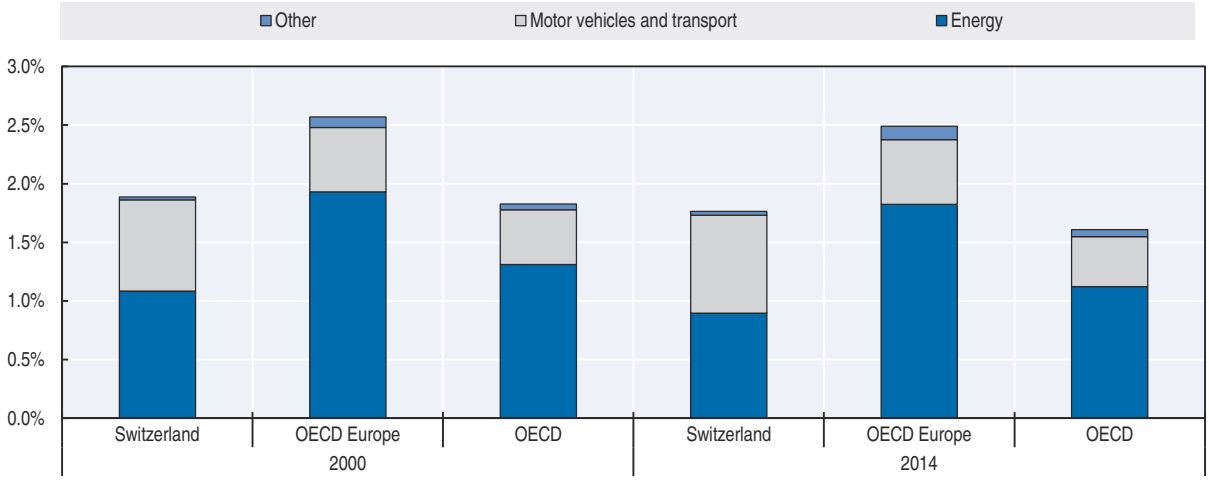
3.1. Overview of environmentally related taxes

Switzerland is characterised by a strong fiscal position (Chapter 1). However, social and infrastructure-related spending needs are expected to rise, placing a significant focus on spending efficiency (OECD, 2015a). The ratio of accrued total tax revenue to GDP has been stable: it was about 27% in 2014, significantly lower than in neighbouring France (45%), Italy (44%), Austria (43%) and Germany (36%), but similar to the ratios of, for example, Australia and Ireland. The difference is related in particular to below-average rates for value-added tax (VAT, 8%) and corporate tax (21%).

Internationally comparable environmentally related taxes (ERT) in 2014 were equivalent to 1.8% of GDP. This percentage, which was stable over the review period, is below the 2.5% OECD Europe average (Figure 3.1). ERT represented 6.8% of total tax revenue in 2014, on a par with the OECD Europe average and above the OECD average. Unlike in most OECD countries, where energy typically dominates ERT revenue, the share related to road transport has risen steadily over the past 20 years to over 45%. Two trends help explain this: since 2000 the road vehicle fleet has increased by 21% while total final energy consumption has decreased by almost 4% (Chapter 1).

The oil tax, however, still represents close to half of ERT revenue, followed by the cantonal motor vehicle tax (20%), the distance- and weight-based tax on heavy vehicles (15%)

Figure 3.1. **A relatively low environmentally related tax base (% GDP) is balanced between transport and energy**



Source: OECD (2017a), "Environmental policy instruments", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571473

and the CO_2 tax on heating and process fuels (5%) (Federal Council, 2013). The incentive tax on volatile organic compounds (VOCs) represents a negligible share. In addition to ERT revenue, Switzerland has environment-related fees, including on aircraft landing and a range of waste streams.

Switzerland could boost ERT by expanding the coverage of the distance-based transport tax and introducing new instruments, such as congestion charges. This would help the government face expected fiscal challenges. Although the budget is nearly balanced and the government debt/GDP ratio of 46% is low for the OECD, the government expects a rise in infrastructure and social expenditure in the medium to long term. Switzerland needs to ensure there are no delays in infrastructure investment (Section 5) and in efforts to improve the well-being of the most vulnerable groups.

3.2. Advancing green tax reform

After the 2007 EPR recommended implementing the green tax reform envisioned by the first SDS in 2002, some steps were taken but full implementation appears to face political difficulties despite the country's GDP per capita being significantly above average.

Initial steps included the parliament's 2010 adoption of Motion 06.3190 (known as the Studer Heiner motion after the deputy who introduced it). It called for the greening of the tax system, the inclusion of an environment-friendly tax system as one of six focus areas for a green economy identified in the 2010 strategy proposal that informed the GEAP, and the commissioning of a study providing an overview of the issues at stake (Baur, 2012). In 2013, however, an in-depth assessment by the Federal Council resulted in dismissal of the initial Studer Heiner motion on the grounds that it duplicated existing or planned measures and that the potential for further optimisation was modest and better addressed via individual laws and regulations (Federal Council, 2013). In March 2015, Swiss voters rejected (by 92%, with a 42% turnout rate) a popular initiative by the centrist Green Liberal Party to replace VAT with a tax on non-renewable energy sources (oil, natural gas, coal, uranium). The aim was to support the GHG reduction target and nuclear energy phase-out by promoting renewables

and energy efficiency while preserving revenue and economic competitiveness. This initiative, like the Green Economy initiative rejected in September 2016, was likely perceived as too ambitious in the short term.

In 2011, after the Fukushima accident, the parliament undertook to reform Swiss energy policy and asked the Federal Council to prepare an energy strategy to foster a shift from nuclear power to renewables by 2050. In 2013 the government submitted a first package of Energy Strategy 2050 measures. On 30 September 2016, the parliament prepared the necessary amendments to the Energy Act, which were approved by referendum on 21 May 2017. The first package, covering 2018-20, provides financial support, via levies on electricity bills, to cover part of the cost of investment in renewables. Electricity consumers also subsidise renewables development via market premium and market price support (feed-in tariffs). This means electricity consumers will assume the cost of the energy transition. The act underwent a referendum because the policy involves a differentiated financial effort between households, small and medium-sized enterprises (SMEs) and large firms to support the energy transition. The case of a CHF 00.023/kWh supplement on electricity bills paid exclusively by households and SMEs (and reimbursed to large firms) illustrates this. Looking ahead to 2021 and the second stage of Energy Strategy 2050, the government has begun to explore options for shifting the basis of the energy transition policy from support by electricity consumers to tax incentives related to energy and climate. On 28 October 2015, the Federal Council sent the parliament a draft of the required constitutional amendment for consideration. However, the National Council (lower house) decided on 8 March 2017 not to examine the proposal, and the Council of States (upper house) rejected it in June 2017.

Nevertheless, there are further avenues towards a more coherent pricing and incentive system across climate-, energy- and transport-related activities. Modelling-based analysis indicates that, compared to the status quo, such a system would achieve significant additional CO_2 emission reduction by 2030 with limited negative impact on GDP growth (Ecoplan, 2015). Here, Switzerland could benefit from the experience of countries that have recently implemented fiscally neutral green tax reforms, such as Portugal.

In the process, to avoid a repeat of rejection by the Federal Council and voters, particular attention should be paid to political economy issues. The distributional impact of such measures is, on average, less of an issue in Switzerland than in other countries. Thanks to its relatively high GDP per capita, the country currently has the lowest energy affordability risk in the OECD, as less than 3% of households spend more than 10% of disposable income on domestic energy (Flues and van Dender, 2017).

Switzerland should also consider reducing the frequency and duration of tax revenue earmarking, limiting it to defined objectives and periods. Earmarking enhances transparency of tax revenue use, thereby increasing public support for new or higher taxes. However, in the long run, earmarking reduces flexibility in allocating revenue and thus can lead to resource misallocation, with too much for earmarked activities and too little for other priorities. Once in place, earmarking may also make reform more difficult, as changes need to be agreed on both the tax and expenditure sides. The planned end of public financial support for energy efficiency in buildings in 2019 will eliminate part of the earmarking of the CO_2 tax. The first Energy Strategy 2050 package does the same for renewables by introducing a sunset clause for new feed-in tariff commitments, six years after the package enters into force (Section 5). But other cases will continue, e.g. earmarking of the oil tax and of aircraft landing charges (Section 3.4).

3.3. Energy-related taxes

The most noticeable energy taxes are those on oil sales (close to 50% of ERT revenue in 2010) (Federal Council, 2013) and on heating and process fuel use (CO_2 tax). The oil tax, in its current form, dates back nearly two decades. A generic revenue-generating tax, it mostly applies to road fuels and thus is further discussed in the transport subsection below. All energy sales are subject to VAT at the regular rate of 8%. Final electricity consumption is subject to a further tax to finance grid development (Section 5).

The CO_2 tax is levied on fossil fuels (heating oil, natural gas, coal, petroleum coke, etc.) used to obtain heat or light, to produce electricity in thermal installations or to operate heat-force coupling installations. It was introduced in 2008 as an incentive tax to internalise the external costs associated with CO_2 emissions and encourage both more efficient fossil fuel use and a shift to low-carbon energy sources. Wood and biomass are exempt because they are considered CO_2 neutral**.** The tax rate is defined per tonne-equivalent and hence depends on the carbon content of each energy source. It has been increased twice since its introduction: from CHF 36/tonne in 2008 to CHF 60/tonne in 2014 and CHF 84/tonne (about EUR 77) as of January 2016. The second increase was deemed necessary because CO_2 emissions from thermal power plants in 2014 did not meet the target of a 22% reduction from the 1990 level.

The tax is collected by the Federal Customs Administration at import or wholesale (for fuels stored in registered tax-exempt warehouses). It is based on the CO_2 emissions produced by combustion at standard temperature and pressure (e.g. for large combustion plants) rather than actual emissions, which would provide better emission reduction incentives. In 2016 it brought in about CHF 1 billion. Two-thirds of the revenue is redistributed uniformly to households, regardless of fossil fuel consumption, through a rebate on health insurance premiums, and to businesses in proportion to the number of employees. Most of the remainder (up to CHF 300 million) goes to a programme by which the Confederation and cantons support energy-efficient building renovations (Section 5). A further CHF 25 million is transferred to the technology fund (Section 6).

While the CO_2 tax rate positions Switzerland among leaders in terms of carbon pricing for emissions covered, the tax does not apply to transport fuels (see below) or to CO_2 emissions covered by the Swiss emission trading system (ETS) (see the "Carbon trading and pricing" subsection). Further, GHG-intensive companies may be exempted from the CO_2 tax upon request if they commit to reducing their GHG emissions continuously to 2020. Eligibility criteria are lax, however: the applicant firm proposes its own reduction target based on an "economically viable reduction potential".

While the Swiss combination of policy instruments may be suitable for targeting various emitter categories, it complicates assessment of the CO_2 tax's effectiveness. For 2008-13, the estimated total reduction was 2.5 million to 5.4 million tonnes of CO_2, which represents only 1% to 2% of reported Swiss GHG emissions for the period (FOEN, 2016b). Households achieved up to three-quarters of the reduction, which may imply that industry did not do its share. The primary driver was the replacement of heating oil with less CO_2-intensive energy sources, a shift that tends to be more rapid for households than companies.

A preliminary survey indicates companies that committed to reducing their emissions in exchange for tax exemption implemented more effective emission reduction measures than companies subject to the tax (FOEN, 2016c). This may partly be explained by the limited incentive provided by the tax's lower rates in its early years, and partly by a tendency for

larger companies to seek the exemption and smaller ones to remain subject to the tax. Companies in the voluntary reduction programme may also have lower GHG abatement costs. Thus it will be difficult to assess the additional reduction effort by companies exempted from the tax until compliance with targets is fully monitored in 2021, after the commitment period ends.

3.4. Transport-related taxes

Transport of persons and goods has been increasing faster than population and GDP growth (Chapter 1). Transport remains the primary source of local air pollution by nitrogen oxide (NO_X) emissions, which are growing, as well as of noise pollution. The impact of transit through the Alps has been an area of particular concern, where Switzerland continues to aim for a modal shift from road to rail. Over time the country has introduced a range of transport-related taxes, as illustrated by the high and increasing share of transport in ERT relative to other OECD countries (Figure 3.1).

Motor vehicles

Vehicle owners pay an annual tax to their canton of residence for every registered vehicle: the cantonal motor vehicle tax, which is the country's oldest existing tax and accounts for 20% of ERT revenue (Federal Council, 2013). The rate depends on the car's weight, power, or both. The rate disparity among cantons can be significant, partly due to variation in cantonal tax burdens and in how cantons finance road construction and maintenance. For example, Bern canton calculates the tax based on vehicle weight: CHF 240 for the first 1 000 kg, with every additional tonne taxed 14% less than the previous one. In other cantons, such as Zurich and Aargau, vehicle type and cubic capacity determine the rate.

Energy-efficient and electric vehicles benefit from exemptions or reductions in some cantons. Hybrid cars are exempt in Basel-Landschaft canton and, for the first three years, in Geneva canton (CEPE, 2015). Basing the motor vehicle tax rate on weight or power, however, continues to create perverse incentives. In particular, for the country as a whole the tax on electric vehicles remains relatively high despite the environmental criterion being taken into account. Overall, although some reductions are driven by green criteria, the motor vehicle tax remains a standard revenue-generating tax for the cantons.

A separate tax is paid at the time a vehicle is registered. Some cantons (e.g. Geneva, Obwalden) reward buyers of less polluting cars via a bonus-malus programme; there is no national standard yet. Bonus-malus systems can be effective. Results from one study (Alberini et al., 2016) point out that the retroactive nature of the malus in Obwalden led to inefficient vehicles being taken off the road faster, which did not happen in Geneva where there was no retroactivity. If not offset by revenue from the malus, the bonus generates a net deficit for cantonal budgets. Overall, registration taxation can help change fleet composition, as for example in Israel (OECD, 2016a), but it is less environmentally effective than taxing fuel or emissions because it is not linked to vehicle use.

The Constitution (Article 82) does not authorise tolls for the use of public roads, saying they must be free of charge (exempt from tax), though the Federal Assembly may authorise exceptions. Highways and freeways are subject to a low annual motorway toll: CHF 40 for unlimited use. As in many OECD countries, the revenue is earmarked for motorway construction and maintenance. Cantons may also charge road tolls under certain conditions, such as for infrastructure developed as part of a public-private partnership. Road tolls can be a very cost-effective way to tackle urban air pollution from traffic congestion. Switzerland

should consider expanding the scope of exceptions to Article 82 and authorise tolls for urban road use. This would allow for congestion pricing, similarly to that in London, Milan and Stockholm. It would also make it possible to consider expanding the scope of distance-based incentives for freight vehicles of less than 3.5 tonnes and for passenger vehicles, which could be critical in limiting road transport overall (Chapter 1).

DETEC has been pilot testing a mobility pricing initiative mandated by the Federal Council in its 2011-15 term. The initiative is exploring the possibility of pricing mobility towards more effective demand-side management across transport modes and services. It could include incentives for off-peak travel load spreading, as well as differentiating charge rates based on vehicles' pollution emissions. This instrument (which would be new in Switzerland) would not come on top of existing transport-related taxes and fees but rather progressively replace them. Consultations conducted in 2015 revealed that the majority of cantons and civil society are favourable to the principle of mobility pricing.

Switzerland is an essential link in freight transit between northern (e.g. port of Rotterdam) and southern Europe. In this context, a Swiss tax on heavy goods vehicles was introduced in 2001 to replace the so-called royalty fee on heavy vehicle traffic. Switzerland thus became one of four OECD countries (with Austria, the Czech Republic and Germany) to have a nationwide road pricing system for heavy goods vehicles. The Swiss system is the only one covering all roads rather than being limited to highways as in the other three countries. The tax is based on distance covered and vehicle weight. It is further differentiated on the basis of pollutants emitted (using the EURO standards) to encourage fleet renewal with less polluting vehicles. Thanks to this and the distance element, the tax partly complies with the polluter-pays principle.[1] It is levied on all freight vehicles and trailers above 3.5 tonnes, whether licensed in Switzerland or abroad. Revenue is earmarked for construction of transalpine rail tunnels (Section 5) and coverage of road-related noise externalities.

The heavy goods vehicle tax appears to have helped encourage modal shifting of freight from road to rail, as the Alpine Initiative requires.[2] By end 2014, more than two-thirds of freight travelled by train in Switzerland (FOT, 2016). With the December 2016 opening of the Gotthard Base Tunnel, at 57 km the world's longest rail tunnel, the share is expected to rise further, as the tunnel aims to increase rail traffic between northern and southern Europe. For now, however, Switzerland is far from reaching its 2018 goal of no more than 650 000 trucks crossing the Swiss Alps per year. Despite a 30% reduction between 2000 and 2014, 1 million heavy goods vehicles travelled through the Alpine region in 2015 (FOT, 2016).

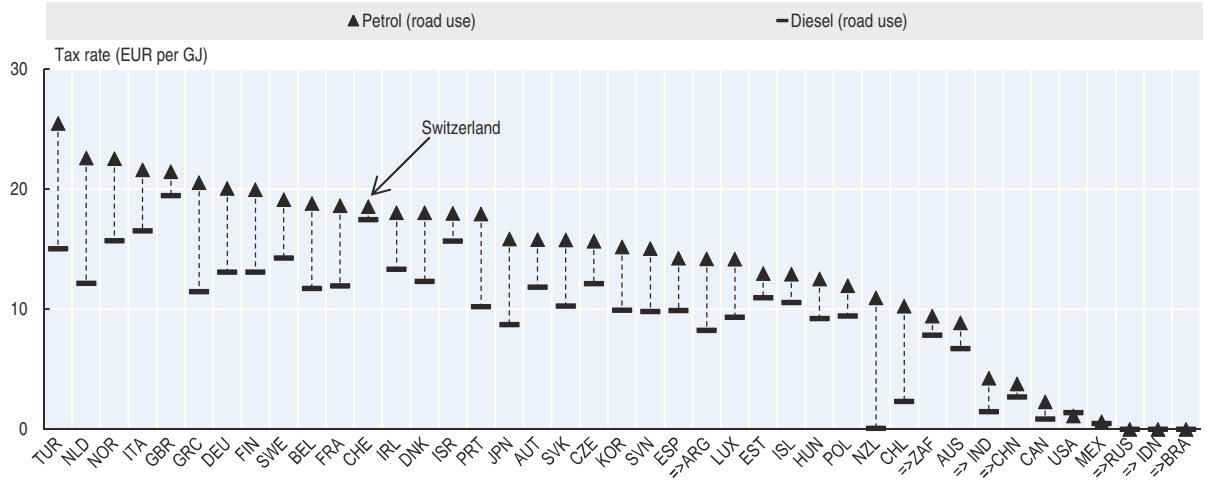
In terms of renewal or upgrade of the heavy goods vehicle fleet, the differentiation of the heavy goods vehicle tax appears to have had considerable impact (OECD, 2005). The 2007 EPR recommended continuing to price transport-related environmental externalities by strengthening and expanding the scope of distance-based incentives. Updated differentiated fees were introduced in 2012 to promote the more stringent EURO VI standards as well as diesel particle filter retrofits for EURO II and III. They continue to be an effective driver for fleet upgrades towards less polluting vehicles. Further updated classifications entered into force on 1 January 2017: low-emission vehicles in the EURO VI category no longer benefit from the 10% rebate introduced in 2012 and are subject to a tax rate of CHF 0.028 per tonne-kilometre.

The heavy goods vehicle tax provides better incentives to reduce air pollutant emissions than the Eurovignette, its counterpart in Denmark, Luxemburg, the Netherlands and Sweden. Introduced in 1995, the Eurovignette is not distance based (it is calculated on weight

and the EURO standards) and applies only to vehicles above 12 tonnes using motorways and toll highways. To speed reduction of heavy goods vehicle journeys, the heavy goods vehicle tax rates should be gradually increased, taking into account road toll developments in neighbouring countries to avoid traffic leakage. Beyond national policy in this area, further reductions relating to long-distance journeys greatly depend on efforts in other countries. For instance, France and Austria have a much lower share of rail in transalpine freight transport.

As regards road fuel taxation, Switzerland is one of only three OECD countries (with Mexico and the United States) that tax diesel at a higher rate than petrol, which makes environmental sense given the higher carbon and air pollutant emissions of diesel fuel. The current rates are CHF 0.73/litre for unleaded petrol and CHF 0.76/litre for diesel, including the oil tax (FCA, 2017). In terms of EUR per GJ, however, the Swiss tax rate for petrol is higher than that for diesel, although the gap between the two is much smaller than in most other countries (Figure 3.2).

Figure 3.2. **Switzerland has one of the narrowest tax differentials between diesel and petrol**



Note : Tax rates are as of 1 April 2012 (except for Australia and Brazil 1 July 2012; and South Africa 4 April 2012). Data for Canada, India and the United States show only federal taxes. New Zealand applies a per-kilometre road user charge to diesel vehicles, which is not included.
Source: OECD (2015b), Taxing Energy Use 2015: OECD and Selected Partner Economies.

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The 2007 EPR recommended increasing the tax levels for both fuels to further improve the pricing of environmental externalities. This was not done; in fact, inflation eroded the tax rates in real terms. Furthermore, depending on the exchange rate between the euro and the Swiss franc, fuel prices in Switzerland have sometimes led to sales of significant volumes to drivers from neighbouring countries (OECD, 2013a). After the appreciation of the Swiss franc against the Euro in early 2015, however, fuel tourism to Switzerland decreased significantly, causing a significant dip in road fuel tax revenue (-5.1% in 2015). Increasing the tax levels for diesel and petrol can help compensate for this in the short term and encourage reduced domestic fuel consumption.

The possibility of expanding the CO_2 tax base to road fuels was considered, but a parliamentary consultation led to abandoning the idea due to the unlikelihood of public support. Hence, while motor fuels are within the scope of the CO_2 Act, they are exempt from the CO_2 tax, as are road fuel imports[3] (unlike fuel imports for processes and heating).

However, over 2006-12, a separate tax of CHF 0.015/litre on petrol and diesel imports was used to finance the Climate Cent Foundation, a voluntary programme set up by the Swiss business sector to undertake GHG reduction projects in Switzerland and abroad.[4] Since 2012, Switzerland has imposed penalties on car imports so as to green its fleet. Like the EU, it has introduced CO_2 emission regulations for new cars, which took effect on 1 July 2012. Swiss importers had to reduce the level of CO_2 emissions from cars registered for the first time in Switzerland to an average of 130 grams/km by 2015. If the CO_2 emissions per kilometre exceeded the target level, a penalty applied as of the above date. The CO_2 standard for passenger cars will be lowered to 95 grams/km as of 2020, and extended to light duty vehicles.

Tax treatment of company cars and commuting expenses

As in many other OECD countries, a special tax regime applies to personal use of company cars and to commuting expenses. A recent OECD study (Harding, 2014) estimated that the Swiss tax system captured barely 20% of a benchmark for neutral tax treatment of company car benefits relative to cash wage income; the country ranked 22nd out of the 26 countries examined. Only 10% of a company car's acquisition value is added to the employee's annual taxable income, and fuel costs paid by the employer do not count as taxable income. Employees have a perverse incentive to be paid part of their salary in the form of company cars, and no incentive to limit their use or to choose efficient vehicles.

Deductions related to commuting expenses are available. As an incentive to favour public transport over personal cars, the full cost of an annual subscription is deductible. Switzerland is the only country besides Germany to provide an annual fixed sum deduction for employees cycling to work. Expenses related to commuting by car are deductible only if deemed necessary due to distance or unavailability of public transport; such deductions are calculated at a rate of about EUR 0.7/km, significantly higher than in other countries with similar deductions: Germany comes second at EUR 0.3/km (Harding, 2014).

As Chapter 1 noted, volumes of personal transport (train and road) have been increasing in Switzerland faster than population and GDP. The tax treatment of company cars and commuting expenses has likely contributed to this trend. The mobility pricing project provides opportunities to make environmentally beneficial adjustments, such as increasing the taxable share of a company car acquisition value and creating explicit incentives to buy more efficient vehicles.

Aviation

Switzerland has had landing charges since 1981 at its major airports in relation to noise caused by aircraft. The revenue is earmarked for noise remediation measures and compensation payments to residents. An additional landing charge related to aircraft NO_X emissions was introduced in Zurich (1997), Geneva (1998), Bern (2000) and Basel (2003). Upon introduction of the NO_X emission charge, the noise-related charge was lowered on a similar order of magnitude to ensure revenue neutrality for airports.

Together with Sweden, Switzerland was the first country to introduce an emission-based landing charge. The Swiss instrument was aligned in 2010 with a tax model now harmonised throughout Europe. Until then, the level of the NO_X charge was differentiated by engine classification in order to favour aircraft using the best available low-emission engine technology. Since 2010, the differentiation has been refined to bring the rate closer to actual NO_X emissions, thus reinforcing application of the polluter-pays principle.

Since 2009, the revenue from landing charges has been earmarked for security and anti-pollution measures at airports. In 2014, CHF 35 million was allocated to projects spanning 2014-21. So far, available funds have exceeded the demand for anti-pollution projects, despite an increasing number of applications. Examples of such projects involve installation of solar photovoltaic panels and heat pumps, replacement of diesel-fuelled vehicles with electric ones, studies to evaluate the impact of aircraft emissions and ecological compensation measures at airports pursuant to the Act on the Protection of Nature and Cultural Heritage (Article 18b).

Kerosene and aviation gasoline for domestic flights are subject to the oil tax and VAT but not to the CO_2 tax. Two-thirds of the revenue from taxes on kerosene is earmarked for a special air transport fund to finance security, safety and (since 2014) environmental measures. Kerosene used in international flights is not subject to any taxation, pursuant to the 1944 Chicago Convention on International Civil Aviation.

3.5. Carbon trading and pricing

Switzerland fulfilled its international GHG reduction commitment under the Kyoto Protocol through a combination of domestic measures, purchase of emission reduction certificates abroad and the effect of Swiss forests as sinks. Emissions, however, have remained almost constant since 1990 (FOEN, 2016b; OECD, 2015c) (Chapter 1). In light of this trend, the 20% reduction domestic target for 2020 stipulated in the CO_2 Act (30% conditional) and the 50% reduction target for 2030 of Switzerland's Intended Nationally Determined Contribution require increased effectiveness of the combination of carbon pricing instruments currently in use.

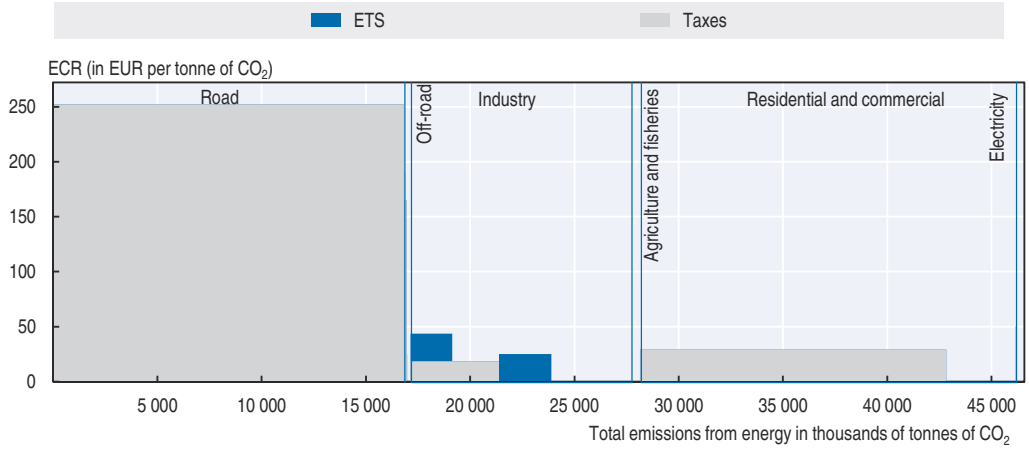
In parallel to the introduction of the CO_2 tax, Switzerland introduced an ETS for GHGs in 2008, three years after the EU and before any country of North America or Asia (OECD, 2016b). Under the CO_2 ordinance, the ETS covers CO_2, NO_2, CH_4, HFCs, NF_3, SF_6 and PFCs, though in practice monitoring and reporting are compulsory and effective only for CO_2, NO_2 and PFCs. Over 2008-12 the system was voluntary, as an alternative to paying the CO_2 tax. Since 2013 it has been mandatory for large, energy-intensive installations and companies, chiefly in cement, chemicals, pharmaceuticals, refining, steel, paper and district heating. Medium-sized companies may join voluntarily. In all, 55 companies were included as of 2016. The ETS accounts for 11% of national emissions, compared with 45% for the EU ETS, 66% for the Korean ETS and 85% for the Californian and Quebecois cap-and-trade systems (ICAP, 2016).

For 2008-12, emission allowances were allocated for free according to targets taking into account the expected activity level of each company. For 2013-20, further free allowances have been allocated to energy- and trade-intensive sectors at risk of relocating abroad and are based on benchmarked emission factors. Other emitters' share of free allowances decrease over time (80% in 2013, declining to 30% in 2020), except fossil fuel thermal power plants. Allowances not allocated for free are auctioned by the Emissions Trading Registry. In 2015, the ETS cap was 5.44 million tonnes of CO_2 equivalent (Mt CO_2 eq). It will decrease by 1.74% a year to 4.9 Mt CO_2 eq by 2020.[5]

The price signal the ETS provides fell from CHF 40.25 in May 2014 to CHF 6.50 in March 2016. This reflects generous initial allowances and limited trading opportunities given the low number of actors covered, but more fundamentally is a result of a hardship regulation to avoid an unreasonable burden for companies covered. In 2012 in the industrial sector, an estimated 24% of emissions were covered by the ETS only, 21% by taxes only (on oil

and/or CO_2) and 19% by both a tax (on oil) and the ETS (OECD, 2016b). Smaller GHG-intensive companies not participating in the ETS are exempt from the CO_2 tax if they commit to reducing their emissions through binding agreements. As a result of the limited coverage and modest trading price of the ETS, most non-road Swiss GHG emissions remain unpriced or low priced on an effective carbon rate basis (Figure 3.3). Higher pricing on emissions outside transport is, therefore, needed.

Figure 3.3. **Most Swiss non-road GHG emissions remain unpriced or low priced on an effective carbon rate basis**



Note : Effective carbon rates (ECR) consist in the price of carbon emissions resulting from the combination of taxes on energy use, carbon taxes and tradable emission permit prices.
Source: OECD (2016b), Effective Carbon Rates: Pricing CO2 through Taxes and Emissions Trading Systems.

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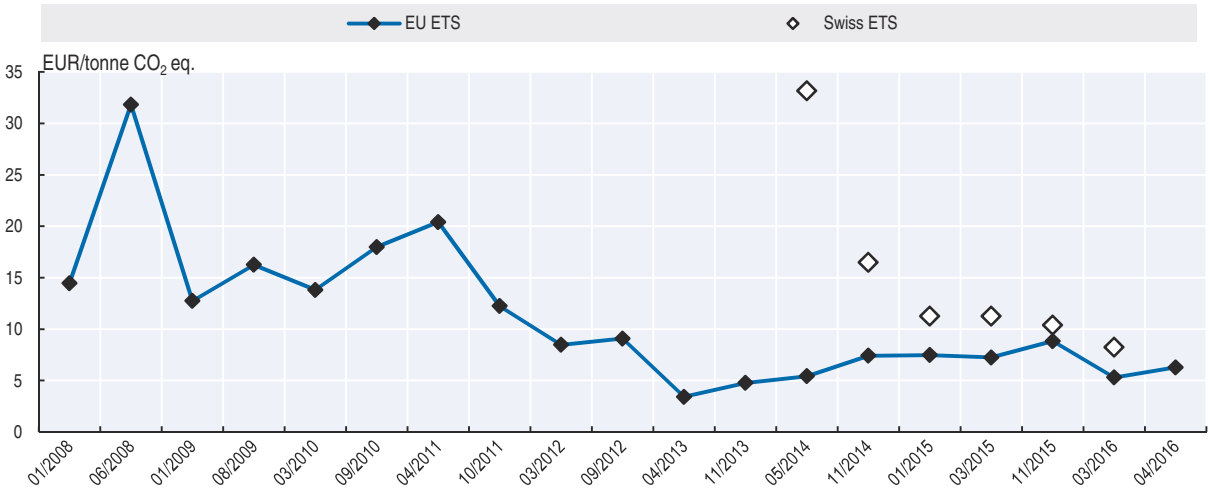
Negotiations to link the Swiss and EU ETS via mutual recognition of emission allowances were initiated in 2008 and concluded in 2016. Ratification of the link is a core element of consultation on future Swiss climate policy, which ended in November 2016. Many elements of the Swiss ETS already match EU ETS provisions (e.g. benchmarks for attributing emission allowances). Further adjustments will be needed, however, particularly to define terms for inclusion of aviation emissions, which are covered by the EU but not the Swiss ETS. As long as the systems are not linked, conditions for participating companies remain different. The significantly higher Swiss price in the first rounds of auctions in 2014 led the Federal Council to adopt the hardship regulation to avoid potential competitive disadvantages for Swiss companies. As a direct consequence, prices then drew closer to the EU ETS level (Figure 3.4).

From the Swiss side, potential benefits mainly lie in addressing issues related to the small size of the Swiss ETS. The link is expected to enable more cost-effective emission reductions, enhanced liquidity, clearer price formation and price stability (ICAP, 2016; IETA, 2015; OECD 2015c). From the other side there are potential areas of concern. One relates to the limited impact of the EU ETS on investment behaviour to date due to the availability of too many emission allowances and resulting low allowance prices. This will lead to decreased incentives for Swiss companies unless the EU ETS is reformed by reducing emission caps and introducing allowance reserves (OECD, 2016c). Furthermore, future interaction between the coverage of the linked systems, on the one hand, and the Swiss domestic CO_2 tax and voluntary emission reduction programme, on the other, will need to be

Figure 3.4. **Carbon prices under the Swiss and EU ETS have reached equally low levels**



Source: Thomson Reuters (2016), Datastream Database; Swiss Emissions Trading Registry (2016).

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rationalised. A deep decarbonisation pathway simulation indicates that a long-term target of 1 tonne of CO_2 per capita in the energy sector can be achieved in Switzerland if a uniform CO_2 price of about CHF 500 per tonne of CO_2 is in effect by 2025 (Ecole Polytechnique Fédérale de Lausanne, 2017).

Finally, Switzerland's 2030 climate mitigation target relies heavily on international offsets (Section 1), but it is unclear how that would be compatible with the EU's intention to focus solely on domestic emission reduction targets from 2020 onwards. The impact in this context would be minor given the low level of Swiss ETS emissions (the 55 companies account for less than 6 million tonnes) relative to the EU ETS (with 12 000 installations representing 2 billion tonnes). However, this again underlines the dilemma faced by Switzerland in terms of addressing the international impact of its national environmental footprint (production and consumption) without neglecting further domestic actions.

3.6. Tax on volatile organic compounds

VOCs are used as solvents in many industries and are contained in products such as paints, varnishes and certain detergents. Released to the atmosphere, they may interact with NO_X to form ground-level ozone. An ordinance introduced a VOC incentive tax in 2000. The tax applies to VOCs of environmental relevance in terms of emission volumes. The ordinance specifies the taxed VOCs in two lists: one of affected organic substances, the other of products containing VOCs. The tax is levied either at point of import or on entry into production. The rate was initially set at CHF 2/kg of VOCs produced or imported. It was raised to CHF 3 in 2003 and has remained at that level. The revenue (CHF 125 million in 2015) is redistributed in full to households through a rebate on health insurance premiums.

Tax exemption is granted where a stationary installation's VOC emissions are consistently below 50% of the limit value prescribed in the Air Pollution Control Ordinance (further technical and operational eligibility criteria also apply). The tax is refunded if VOCs embedded in industrial use are not released into the environment, or if products containing VOCs are exported. The latter does not help reduce Switzerland's overall ecological footprint.

A 2009 assessment concluded that the incentive tax has had a positive effect on cutting VOC emissions, although expectation of the tax ahead of its introduction appeared more effective than the tax itself. Further, the tax appears less effective than direct regulations applying to substances and products not subject to the tax, under the 1985 Air Pollution Control Ordinance and EU legislation (VOC Solvents Emissions Directive, 1999/13/EC) for imports. However, the tax has raised awareness of the environmental and health problems linked to VOCs and encouraged innovation in three key industries: printing, paint making and metal cutting (OECD, 2010).

Switzerland has set a 30% VOC emission reduction target by 2020 from 2005 levels. In recent years, however, emissions have been more or less unvaried in all activities, whether or not subject to the VOC tax. Meeting the target under a business as usual scenario will be challenging given the increasing marginal costs for industry to find substitutes for VOCs and VOC-containing products and the difficulty of assessing consumption patterns. Combining the tax with direct regulations (i.e. taxing VOCs and VOC-containing products that do not meet the requirements of the Air Pollution Control Ordinance) can enhance effectiveness, particularly with higher tax rates and/or more stringent legal requirements.

3.7. Waste-related fees

The Environmental Protection Act stipulates that MSW management must be financed according to the polluter-pays principle. A bin-liner fee was introduced as early as 1975 and is now in place in 90% of municipalities. But MSW is an area that illustrates Switzerland's difficulty in reducing its consumption-related environmental impact. As Chapter 1 noted, landfilling has been eliminated (following a prohibition on disposing of combustible waste in landfills) and recycling rates have increased with the introduction of fees. However, the combined fee system has not proved effective in reducing MSW generation per capita, which has continued to rise since 1975 and remains significantly above the OECD average. There is a need to increase waste minimisation incentives (e.g. by raising the bin-liner fee) while managing the risk of illegal dumping.

Difficulties in reducing MSW generation may be due in part to the large and stable share of incineration, a disposal technology that not only is less environmentally desirable than reuse and (in most instances) recycling, but also requires constant incoming volumes to avoid underutilisation and remain profitable. Incineration has been at the heart of Switzerland's waste disposal strategy since landfilling of combustible waste was prohibited in 2000. The construction of 30 MSW incinerators benefited from public financial support. However, these facilities' operation and maintenance costs have to be self-financed from i) municipal bin liner fees; ii) gate fees on industrial and commercial waste, where incinerators compete with each other; or iii) sales of district heat or electricity from waste-to-energy facilities.

In 2014, incinerator operators signed a voluntary agreement with the federal government to reduce CO_2 emissions by 18% by 2020. In return, however, the waste sector was entirely exempted from the ETS (OECD, 2015c), so the relative effectiveness of the voluntary agreement needs to be assessed. Switzerland should also tackle NO_X emissions from incineration and consider taxation, e.g. as in Sweden.

To encourage recycling, fees are in place for specific waste streams. Prepaid disposal fees are charged on glass beverage containers and batteries. The fee for glass is collected directly from domestic manufacturers and importers. When it took effect in 2002, about 90% of glass was already being recycled, based on a separate collection stream since the 1970s. The focus, therefore, is on promoting the best possible ecological reuse of waste

glass. For batteries, the fee is included in the sale price of each battery and accumulator. FOEN's current target is to raise the collection rate from around 72% of used batteries to 80%, but the target does not consider options for reducing demand for batteries. Other prepaid recycling fees exist for PET beverage containers, aluminium and food cans. Over the past 25 years, recycling rates have risen (e.g. to over 80% for PET), but in a context of increasing volumes of MSW generated. Switzerland should set waste management priorities according to the waste hierarchy, favouring reduction over reuse and recycling.

For electrical and electronic equipment there is an extended producer responsibility programme in which producers and importers are required to pay an advance recycling fee for equipment they place in circulation. The funds are used to finance the collection and recycling of equipment by three private sector systems. Here again, the fees have had a positive effect in that Switzerland has one of the world's best collection and recycling results, but they appear not to have reduced waste volumes generated. Furthermore, although Switzerland pays special attention to recovery of imported rare metals with a view to more economical resource management, current fees and policy instruments do not address the broader issue of the global impact of electronic waste, significant volumes of which are exported and treated abroad, particularly in non-OECD countries.

4. Removing environmentally harmful subsidies and tax exemptions

A 2013 report by the Federal Council provides an overview of environmentally harmful subsidies and tax exemptions. The report was prepared in response to, and as a means of dismissing, the Studer Heiner motion calling for green tax reform. It found that tax exemptions accounted for the majority of the value concerned, particularly in agriculture (VAT exemption) and aviation (absence of excise tax on kerosene, in line with the Chicago Convention). The assessment indicated such measures cost the government over CHF 5 billion a year (Table 3.1). This sum is equivalent to almost 40% of the 2010 revenue of Swiss environmentally related taxes, which totalled CHF 11 billion for internationally comparable ERT plus CHF 2.7 billion for other ERT (Federal Council, 2013). The design of a more coherent pricing and incentive system across climate-, energy- and transport-related activities would provide a good opportunity to reassess such subsidies and exemptions.

4.1. Transport- and energy-related support to fossil fuel consumption

Final consumption of energy in Switzerland is dominated by imported fossil fuel products, with oil (37%) and natural gas (11%) representing close to 50% in 2014 (IEA, 2016). As Switzerland does not produce crude fossil fuels, its support to fossil fuel consumption only concerns industrial and final consumers (OECD, 2015d; OECD, 2013b). The annual support has been estimated at CHF 260 million since 2012 (Figure 3.5), exclusively in the form of tax expenditure (excise and CO_2 tax refunds and exemptions). This places Switzerland among countries with a relatively low ratio of tax exemptions for fossil fuel consumption to total tax revenue (0.1%, compared to the 0.4% OECD average) (Figure 3.5).

Swiss tax exemptions or reductions have historically benefited particular sectors (agriculture, forestry, public transport) (OECD, 2013b). Switzerland does not intend to remove these environmentally harmful subsidies and is even considering extending tax reductions to include snow grooming vehicles.

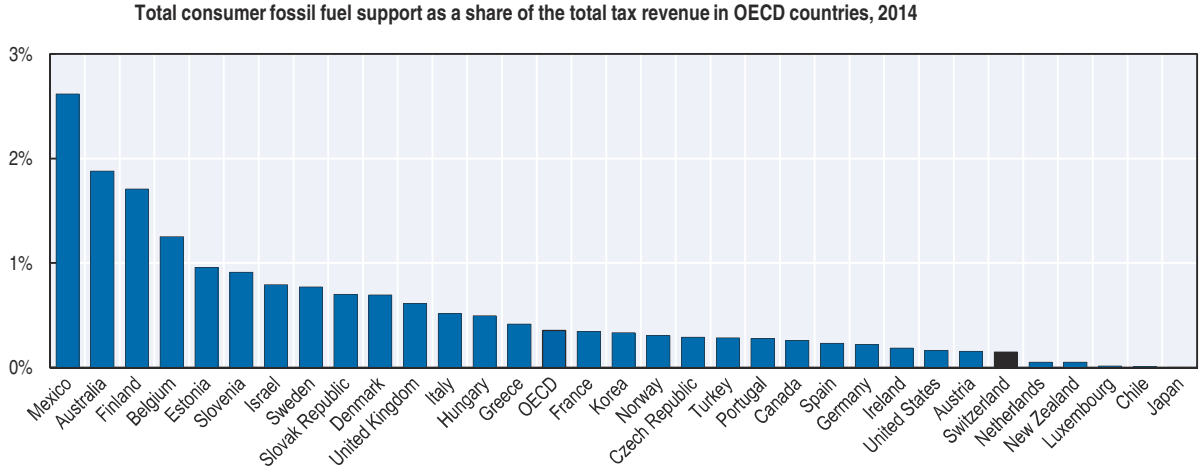
A noticeable trend is the growing share represented by CO_2 tax exemptions in total environmentally harmful subsidies. This is a consequence of the tax rate increase from CHF 12 in 2008 to CHF 84 as of early 2017. Exemptions to the tax thus implicitly provide a rising subsidy

Table 3.1. **Selected environmentally harmful subsidies and tax exemptions (as of 2013)**

Sector	Subsidy/exemption	Description	Correction envisioned	Implementation status
Transport and energy	Exemption from kerosene tax	Tax relief for international air traffic (CHF 1.3 billion), in line the Chicago Convention	Linking international air traffic to GHG ETS	Expected; negotiation with EU ongoing
	Deduction of commuting expenses from federal employment tax	Tax relief for long-distance travel between home and work (CHF 500 million)	Capping relief at CHF 3 000/year	Expected in the context of developing railway infrastructure
	Heavy goods vehicle tax base	Vehicles < 3.5 tonnes not covered (CHF 240 million)	Extending tax base to all freight vehicles	Not expected due to poor cost-benefit ratio
Agriculture	Subsidies for livestock herds	Headage payments (CHF 500 million)	Phasing out direct payments	Done under Agriculture Policy 2014-17
	Subsidy to dairy industry	Output-based support (CHF 300 million)	Making environmental adjustments to subsidy	Being considered under Agriculture Policy 2018-21
	Reimbursement of oil tax and surtax	Tax relief for agriculture and forestry (CHF 135 million)	Stopping the reimbursement	Not expected due to low potential for ecological optimisation
	Exemption from heavy goods vehicle tax	Tax exemption for agriculture	Extending tax to agricultural vehicles	Not expected due to low potential for ecological optimisation
Property	VAT exemption	Exemption for rent (CHF 2 billion)	Extending VAT to rent	Not expected under current VAT policy
	Property tax relief	Undervaluation of rental value used to calculate property tax (CHF 235 million)	Using criteria other than rental value to set property tax	Considered but not prioritised; rejected on several occasions

Note: All amounts are approximate.
Source: Federal Council (2013), *Rapport du Conseil fédéral sur le classement de la motion 06.3190 (Studer Heiner) du 8 mai 2006 : Ecologisation de la fiscalité et des subventions*, *www.admin.ch/opc/fr/federal-gazette/2013/4989.pdf*.

Figure 3.5. **Swiss fossil fuel consumer support represents a notably low ratio compared with total tax revenue**



Notes: Data for Australia include large fuel tax credits, which explain its relatively high ratio. The credits are a rebate on some excise taxes businesses pay on fuel purchases. Data for Greece are for 2010-11.
Source: OECD (2017e), "OECD Inventory of Support Measures for Fossil Fuels", *OECD Environment Statistics* (database); OECD (2017c), "Green Growth Indicators", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571549

for GHG emissions. The tax's impact and effectiveness are particularly diminished by the exemption of transport fuels and GHG-intensive companies (on international competitiveness grounds). To be exempted, SMEs must commit to CO_2 emission reduction targets (Section 3). Recent assessments commissioned by the government reveal that tax-exempt SMEs have taken steps to reduce emissions, but there is no evidence as to whether they would have achieved more or less if subject to the tax. GHG-intensive large enterprises are also exempt from the tax due to their inclusion in the ETS. Although in theory the ETS imposes a cap on the sector's emissions, the price of emission credits under the ETS is much lower than the CO_2 tax level.

Given that Switzerland already performs particularly well in terms of production-based GHG intensity (Chapter 1), further reducing CO_2 emissions in Swiss manufacturing industry would likely entail high marginal costs and hence require a much higher carbon price incentive, which is probably unfeasible in the short term. In this context, CO_2 tax exemptions provide a negative price signal and constitute a policy misalignment. Moreover, the implicit CO_2 tax under the Swiss (or future Swiss-EU) ETS does not provide a price signal anywhere close to the current CO_2 tax. Should Switzerland maintain its policy focus on short-term competitiveness for GHG-intensive SMEs, the risk of lagging behind in low-carbon innovation and performance in the longer term will increase.

In addition to hydropower, Switzerland relies heavily on nuclear power to meet its electricity needs while maintaining a low-carbon electricity mix. The planned phase-out of nuclear power raises the question of a substitute energy source. Phasing out support to fossil fuel consumption would free up resources and create further incentives on the supply side to develop renewables, including hydropower (Section 5), and improve energy efficiency on the demand side. In 2014, for instance, estimated annual fossil fuel subsidies (CHF 260 million) were nearly equivalent to subsidies for use of renewables (CHF 270 million, though the sum rose to CHF 338 million in 2015) (Fondation RPC, 2016). For a country that lacks fossil fuel resources and imports about 70% of its total primary energy supply, fossil fuel subsidies are also an obstacle to energy security.

4.2. Agricultural policy support and land use-related tax privileges

The level of agricultural policy support remains one of the highest in the OECD at over 60% of gross farm receipts in 2013-15. This is three times the OECD average and makes the country one of the largest OECD providers of support relative to GDP, and the largest relative to agricultural value added.

Prior to the 1990s, output-based support created production and trade distortions, including in relation to developing countries, and barely considered environmental safeguards. Since the agricultural reforms initiated in the 1990s, Switzerland has increasingly responded to a number of agri-environmental challenges (Chapter 1). Importantly, an increasing share of direct payments to farmers is now explicitly based on environment-friendly practices rather than number of hectares farmed or livestock headcount. Moreover, payments are conditional on satisfying environmental criteria, such as frequent crop rotation and low nutrient use (OECD, 2016d; OECD 2015e). Further reforms should seek to achieve absolute decoupling of environmental performance from agricultural production. However, market price support and some output-based direct payments remain (e.g. a lump sum per hectare to ensure food supply). While their aim is to support farm incomes, they have no positive effect on environmental goals, and may even impede achievement of environmental policy objectives.

Switzerland plans to make further positive adjustments (e.g. strengthening ecological requirements in dairy production) in Agriculture Policy 2018-21. It should pursue its efforts to

explicitly put agricultural policy support at the service of achieving agri-environmental objectives, including by removing remaining fossil fuel-related tax exemptions and reductions in the sector, e.g. on oil use and on methane emissions. In April 2016, the National Council (lower house) proposed to stop taxing farmers' earnings from selling their land after it is rezoned for non-agricultural purposes. This proposal, now pending approval by the Council of States court, would further encourage urban sprawl and its undesired externalities. It would come in addition to cantonal property taxes[6] and communal taxes[7] that already provide strong fiscal incentives to local authorities to make large plots of land available on the outskirts of municipalities in an attempt to attract high-income taxpayers (Blöchliger et al., 2017).

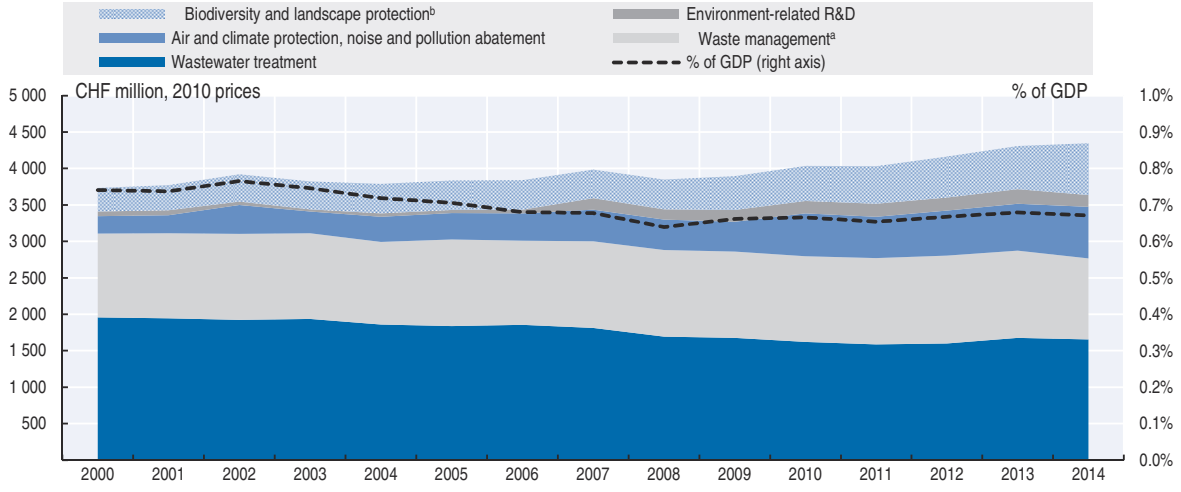
5. Environmental protection expenditure and infrastructure investment in support of green growth

5.1. *Environmental protection expenditure*

The share in GDP of public environmental protection expenditure (EPE) decreased between 2000 and 2008, then after the financial crisis stabilised at around 0.7% (CHF 4.3 billion), in line with the EU average (Eurostat, 2016). As in other OECD countries, most EPE goes to sewage treatment, although its share has been decreasing since 2000, reflecting progressive application of the polluter-pays principle.

Expenditure on air and climate, and to a lesser extent on biodiversity and landscape, has increased significantly (Figure 3.6). The rise reflects increased efforts to curb CO_2 emissions since the introduction of the CO_2 tax in 2008. The steady decrease of EPE on sewage treatment since 2000 reflects the decline in investment needs at sewage treatment plants, which are already equipped with tertiary treatment, though upgrades to better treat micro-pollutants have been under way 2016 (Chapter 4). EPE on MSW management has slightly decreased despite the rising volumes generated, possibly as a result of increased recycling and stable use of installed incinerator capacity (Chapter 1). EPE on biodiversity and landscape (Chapter 5) is closely linked to related public financial support, which has continued to increase under Agriculture Policy 2014-17.

Figure 3.6. **Total public environmental protection expenditure was stable over 2000-13**



Notes: a) Excludes household waste incineration plants. b) Includes direct environmental payments to the agricultural sector (since 1993).
Source: FSO (2016), "Environmental protection expenditure", Territory and the Environment (database); OECD (2016e), *OECD National Accounts Statistics* (database).

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EPE is shared between the federal, cantonal and municipal levels (Chapter 2). Since the 2008 fiscal equalisation reform, federal transfers to cantons have had to follow joint programme agreements which include EPE. Plans call for federal transfers supporting cantonal biodiversity activities to double in 2016-19, reaching up to CHF 60 million a year (Chapter 5). The reform also requires rich cantons to support poor (often mountain) cantons.

Looking ahead, Switzerland expects environmental expenditure to increase as ageing infrastructure (e.g. urban wastewater pipelines) is replaced or rehabilitated. In addition, if population, the economy and urbanisation grow as forecast, existing infrastructure will need to be expanded. In this context, demand-side management and incentives for less resource-intensive production and consumption patterns (e.g. new incentives to reduce water and energy use, minimise MSW and foster air and water pollution prevention) could reduce reliance on EPE.

5.2. Greening infrastructure investment

Renewable energy resources

The decision to phase out nuclear power following the Fukushima accident in Japan (2011) prompted authorities to try to speed up deployment of renewables other than hydropower, which already represents over half of electricity generation and around 13% of total primary energy supply (Chapter 1).

In 2009, Switzerland introduced feed-in tariffs (FITs) for electricity generated from renewables (solar photovoltaic, wind turbines, hydropower plants up to 10 MW and geothermal- and biomass-powered plants). The FITs take the form of guaranteed prices per kWh for operators, which cover the difference between production costs and electricity market prices. They are granted for 20 years (10 years for some biomass plants) and are funded by earmarking revenue from the charge on grid use, which is capped by law (Section 3). While the policy reached its initial goal of triggering development of new renewables-based capacity (Fondation RPC, 2016), in 2014 only 3% of the electricity produced benefited from FITs (OECD, 2015c). Switzerland appears to have voluntarily aimed at relatively slow development to avoid windfall profits, to keep running costs manageable in the FIT programme and, when it comes to wind power, to protect landscapes.

In 2014, FIT adjustments were made for solar photovoltaic installations on dwellings. A one-off investment grant, instead of a recurring FIT, may now cover up to 30% of the installation costs of photovoltaic panels, thereby encouraging self-consumption of the electricity produced. Furthermore, the FIT was cut by between 12% and 23%. Such measures were driven by falling electricity prices and technology costs as well as high demand for household photovoltaic installation, which resulted in a long waiting list. Early assessment indicates that the adjustments have been effective in addressing FIT-related issues such as windfall profits in some instances and the cost burden of the long-term payment commitment (Fondation RPC, 2016). However, budgetary and market price support to renewables should be further optimised to sustain the financial viability of such a policy in a scenario of increased development of renewables-based installations.

As of 2018, the first package of Energy Strategy 2050 measures will replace FITs with private contracts (contracts for difference) and introduce additional investment grants, thereby moving to solutions for supporting renewables development that are more responsive to changing market conditions. Such moves will be critical to creating the conditions for renewables to contribute their share to a time- and cost-efficient nuclear

phase-out while avoiding increased reliance on imported fossil fuels. Further steps can be taken to this end. While an auction system is not applicable due to the small size of the Swiss market, tenders can be considered for allocating FITs (OECD, 2015a). This could build upon the energy-efficiency competitive tenders introduced in 2010 for industry. Tenders would require FIT applicants to demonstrate that their investments would not be made in the absence of support. Such an "additionality" prerequisite to avoid windfall profits already applies for energy-efficiency competitive tenders. It can meaningfully be replicated for investment in renewables. In the longer run, carbon pricing remains the most cost-efficient way to create incentives for favouring renewables over fossil fuels. Switzerland should consider replacing support with further differentiation of taxation between fossil fuels and renewables in effective carbon rate terms.

Energy-efficient buildings

Switzerland set a target of reducing emissions from buildings by at least 40% by 2020 compared to 1990 levels, with an interim target of 22% by 2015, which was reached. A joint federal-cantonal buildings programme was established in 2010 and is expected to run until 2019. Since 2010, a third of the revenue of the CO_2 tax on heating and process fuels (introduced in 2008) has been earmarked to fund this programme (up to the current CHF 300 million ceiling, to be raised to CHF 450 million in 2018). Two-thirds of this goes to the federal level to subsidise refurbishments and the rest to the cantons (which are to match it with their own funds) to subsidise the use of renewables and waste heat. As Section 3 noted, earmarking has significant shortcomings. But in the case of the buildings programme, redistributing a tax paid by occupiers to owners of the flat to enable them to improve energy efficiency makes economic sense. The occupier ultimately benefits from the improvement through reduced energy bills, while the owner would otherwise probably not have undertaken the improvements unless required to by the building code.

The rises in the CO_2 tax rate in 2013 and 2016 increased funding availability for the buildings programme in comparison with the first redistribution of the tax revenue in 2010. Between 2010 and 2014, CHF 1 billion was allocated to the programme, making it possible to refurbish some 17 million square metres of building area and install nearly 5 000 wood heating systems, 30 000 solar thermal collectors and 8 500 heat pumps. It is estimated that by 2020 the average annual CO_2 reduction effect, compared with business as usual, will be 1.2 million tonnes, which falls short of the CO_2 Act objective of 1.5 million to 2.2 million tonnes. While the federal level of the programme is on track, the cantonal level has underachieved. This can be explained by the fact that available cantonal funds are lower than predicted due to budgetary cuts and difficulties in mobilising matching funds. Even so, the programme's cost-effectiveness (estimated at CHF 65 per tonne of CO_2 avoided after four years of implementation) exceeded expectations (Federal Council, 2016b).

In the context of Energy Strategy 2050, the Federal Assembly prolonged the buildings programme beyond 2019 and increased the maximum amount earmarked for it to an annual CHF 450 million, which lowers the cantonal share and will thus partly address the corresponding funding shortfall. Known limitations of existing tax breaks for energy efficiency building renovations (modest incentive effect, significant windfall profit, limited redistribution impact, loss of tax revenue) will have to be addressed (SFOE, 2015; INFRAS, 2015). Policy coherence should also be sought between tenants (the majority of households) and owners.

Sustainable transport

The 2007 EPR recommended targeted public investment supporting a continued transport modal shift from road to rail, in addition to fiscal and incentive measures (Sections 3 and 4). In line with trends observed prior to that, the volume of public spending on rail-related infrastructure investment and maintenance has continued increasing since 2007. Following a rise in road infrastructure investment since 2009, the transport infrastructure in 2012 was split almost equally between road (51%) and rail (46%). By comparison, neighbouring Austria increased the share of rail to over 80% over the same period (ITF, 2016).

New investment is intended to contribute directly to the modal shift policy (Section 3). Earmarking of the heavy goods vehicle tax helped finance construction of the Gotthard Base Tunnel, which opened in December 2016. A rail infrastructure financing programme approved in 2014, following a popular initiative, introduced a permanent infrastructure investment and maintenance fund. Together with traffic demand management measures, cost-efficient ways to finance investment in transport infrastructure will need to be rapidly sought given the projected 50% passenger and 77% freight increases between 2010 and 2030 (Union des Transports Publics, 2016).

Public-private partnerships should be further explored. They have been little used to finance transport infrastructure at the federal level, perhaps in part because of the advantageous financial conditions Switzerland enjoys when raising funds on capital markets. In addition, Swiss pension funds cannot invest more than 15% of their resources in infrastructure. By contrast, several public-private partnership projects have emerged in the cantons. For example, Geneva canton plans to finance a road crossing of Lake Geneva (bridge or tunnel) and the Geneva bypass (estimated at CHF 3 billion) using a 50-year public-private partnership and a toll system. In the first phase (10 years) the private partner would design and construct the projects, at its cost; in the second (40 years) it would operate and maintain them, with the canton paying "rent" financed by a toll it would levy. At the end of the partnership, when the infrastructure is returned to the canton, the toll could be maintained if the infrastructure were declared to be of national scope and included in the national road network. For rail infrastructure, innovative public-private partnerships for cost and benefit sharing would have to be designed.

Differentiated mobility pricing and taxation (Section 3) would also help raise funds for investment in sustainable transport and limit demand for road transport, e.g. through further distance-based taxation. This is especially relevant since increases in public rail transport tariffs, combined with the exclusion of road fuels from the CO_2 tax, have made passenger car use a cheaper option on many routes. However, in this area, perhaps more than others, Swiss direct democracy makes it difficult to adopt policy reforms that restrict personal freedom.

6. Greening investment practices in the corporate and financial sectors

The Swiss economy features many large companies and a sizeable financial industry. Further steps to promote mainstreaming of environmental considerations into business and investment decisions, as well as to mobilise private participation in green investment, would yield significant environmental benefits domestically and internationally. Switzerland has the potential to lead by example. Close institutional co-ordination is required between FOEN and federal entities in charge of private sector regulation, particularly the State Secretariat for Economic Affairs (SECO) and the State Secretariat for International Financial Matters.

6.1. Corporate social responsibility and private investment

Switzerland is a large provider of direct investment in foreign economies, both relative to the size of its economy and in absolute terms. Its outward FDI stock has more than doubled over the last decade.[8] At the end of 2014, it stood at over CHF 1 trillion or 151% of GDP (SNB, 2016), the third largest share in the OECD (after Ireland and Luxembourg). In 2015, Switzerland had the fifth largest outward FDI flows in the OECD, exceeded only by the United States, Ireland, the Netherlands and Japan.

In this context, the environmental sustainability of outward Swiss FDI can significantly contribute to the transition to a greener economy globally. The UN Global Compact Network and OECD Guidelines for Multinational Enterprises (MNE) provide useful frameworks, especially if combined with trade-related provisions (Section 8). Switzerland proactively participates in most activities under the "proactive Agenda of the MNE guidelines" (OECD, 2016f), and has adopted its own Corporate Social Responsibility Action Plan for 2015-19. However, the parliament rejected a legislative proposal to follow MNE guidance for global supply chain effects of Swiss outward FDI. This demonstrates the strong Swiss preference for co-ordinated voluntary approaches over regulatory requirements, as discussed in other sections of this chapter and in Chapter 2.

6.2. Greening the financial sector

Switzerland hosts a significant financial centre (asset managers, commercial banks, equity investors and funds, institutional investors). Financial transactions are estimated to represent 9.3% of GDP, the second largest share in the OECD, after Luxemburg (28.4% of a much less diversified economy). By comparison, the respective UK and US shares are 7.2% and 7.0% (SIF, 2016). Accordingly, the Swiss financial sector can be an important provider of green finance and a primary driver for greening investment practices domestically and internationally.

However, a FOEN-commissioned independent assessment of the environmental performance of the Swiss financial sector suggests a lot remains to be done. From a climate perspective, holdings of the Swiss equity fund market are estimated to contribute to a global scenario of temperatures rising by between 4°C and 6°C (South Pole Group, 2015) rather than being aligned with the international objective of well below 2°C under the Paris Agreement (UNFCCC, 2015). A number of large Swiss banks are among the many international commercial banks that continue to significantly contribute to financing fossil fuel-related investment (Rainforest Action Network, 2016; Fair Finance, 2015). More generally, the share of assets managed according to environmental, social and governance (ESG) criteria remains negligible despite growth in recent years (Swiss Sustainable Finance, 2016).

A significant step in mainstreaming environmental principles entails excluding financing of certain types of projects. In 2015, nuclear energy and so-called ecological destruction were among the ten types of projects that some Swiss investors stopped financing or investing in (Swiss Sustainable Finance, 2016). In 2016, Publica, Switzerland's largest public pension fund, decided to divest from coal companies because of their vulnerability to climate mitigation policies. This type of exclusion, if replicated, would have a significant impact in terms of reducing the financial sector's climate footprint.

Other steps Switzerland has taken to green its financial sector include setting up Swiss Sustainable Finance, a collaborative platform established by SECO to deepen dialogue with the financial sector and promote integration of ESG criteria into investment policies and

processes by asset managers, institutional investors and capital market actors. A team of Swiss government, private sector and civil society experts drafted an indicative roadmap in this area (FOEN, 2016d). Such a collaborative approach has the potential to lead to a significant step forward in greening the financial sector. In 2016, the Federal Council established principles for a consistent policy on environmental sustainability in financial markets (Swiss Confederation, 2016; Federal Council, 2016c).

Switzerland is also engaged internationally, having hosted an international workshop in 2016 on environmental risk analysis in the financial sector, and feeding into the G20 Green Finance Study Group work. It supports multilateral voluntary initiatives such as the Financial Stability Board Task Force on climate-related financial disclosure, the 2° Investing Initiative and the Inquiry into the Design of a Sustainable Financial System project of the UN Environment Programme (FOEN, 2015).

Swiss authorities are, however, reluctant to translate such work into more binding action plans, let alone legislation. Voluntary initiatives and international co-operation are prioritised, with the aim of avoiding excessive burdens on the financial industry and ensuring a level playing field with foreign counterparts. The two do not necessarily have to be mutually exclusive, however, and voluntary initiatives alone are unlikely to deliver at the scale and speed needed to address pressing environmental issues such as climate change. For example, 2015 French legislation introduced a reporting obligation for institutional investors on i) their integration of environment in investment policies, ii) GHGs embodied in their investments, iii) their contribution to meeting domestic and international objectives and iv) the financial risk they face because of climate change. While further methodological development is needed to measure carbon-related financial risk, Switzerland could consider making it mandatory to disclose such readily available factual information as the number and volume of investments in and financing of environmentally harmful (e.g. fossil fuel-related) activities. This could initially be tested with publicly owned entities. If later rolled out to other actors, it could significantly speed up the sensitisation of the financial sector to decisions' environmental impact (including in relation to climate change) and would serve as powerful leverage to encourage behaviour change at scale.

Such information disclosure, however, would not necessarily lead the sector to invest in green infrastructure such as renewables projects. Data on private investment in such projects, along with analysis of public interventions that triggered the investment, would provide clear evidence of the extent to which the financial sector contributes to greening the economy. In this context, obstacles to public-private partnerships at the federal level and to pension funds' participation in infrastructure investment (energy, transport, buildings) should be removed (Section 5).

7. Promoting environmental technology and eco-innovation

7.1. Innovation profile and strategy

Switzerland has a competitive advantage in science, technology and innovation (OECD, 2014a). As a quality-adjusted measure of research output, it has the OECD's largest share of documents with a high citation impact. It also has by far the largest share (over 25 per thousand) of doctorate holders in the working age population, including a significant proportion of graduates from abroad (OECD, 2015f). The latter underlines the country's attractiveness to foreign scientists. Switzerland has an above-average rate of international scientific co-authorships, reflecting a proactive policy of fostering collaboration to promote

networking and joint research and development (R&D) projects (OECD, 2016g; OECD, 2014a). While many countries tend to focus their public research strategy on specialised public institutes, Switzerland gives a more central role to universities. Co-operation with the private sector is also fostered through voluntary economic-environmental collaboration.

Every four years, the federal government releases an overarching research strategy. Over 2013-16 it established three main policy guidelines: reinforce the high level of public R&D (typically through National Centres of Competence in Research), increase provision of well-qualified human capital and create framework conditions conducive to innovation (OECD, 2015f). In addition, four-year master plans for environmental and energy-related research and innovation are prepared, respectively, by FOEN and the Federal Energy Research Commission. Approved by the Federal Council, they serve as planning instruments for all federal bodies and as orientation for cantons and municipalities. In this context, the clear continuity of themes and priorities in the 2013-16 and 2017-20 plans provide a coherent and stable framework.

The environmental research master plans include sustainable resource use as a priority theme (FOEN, 2016e; FOEN, 2012), while the energy research master plans systematically cover four priority themes: energy efficiency in buildings, fuel-efficient and low-carbon mobility, environmentally sustainable energy supply and resource-efficient production processes and products (CORE, 2016; CORE, 2012). Both sets of master plans are closely linked with national strategies for energy (2013), the green economy (2016-19) and sustainable development (2016-19). Research activities relating to the concept of circular economy have received increasing focus across both series of master plans, not only regarding product development and design, but also more holistically in terms of steering economic development. New research plans addressing public transport are being prepared for 2017-20 to support implementation of Energy Strategy 2050.

As part of initial federal steps towards a green economy in 2010, a "cleantech" master plan was released for 2011-14. It focused on climate change and growing natural resource scarcity. It aimed to provide a framework for joint clean technology policy across federal offices, cantons, the business sector, science and research, as well as NGOs. Despite having raised the policy profile of the Swiss clean technology sector, the Federal Council decided in 2016 to discontinue this master plan. The effectiveness of the now looser co-ordination of clean technology activities is to be assessed by 2019.

7.2. Public R&D expenditure and support of eco-innovation

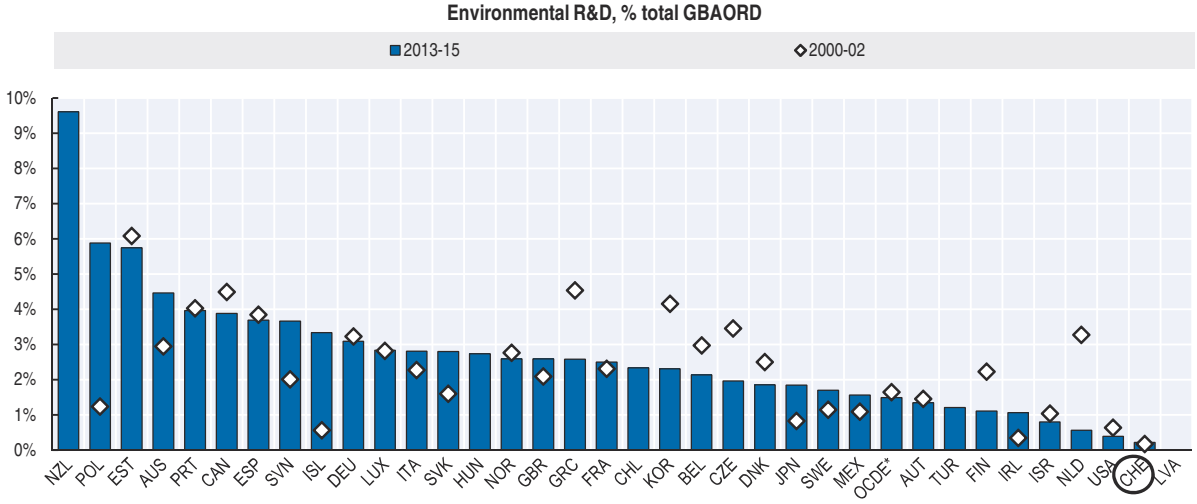
At close to 3% of GDP on average over the review period (3.4% in 2015), Swiss gross R&D expenditure is well above the OECD average (2.4%) but behind front runners such as Korea, Israel, Finland, Sweden and Japan (National Sources; OECD, 2014a). Switzerland is one of the very few OECD countries not offering specific tax concessions for R&D and innovation at the federal level. Rather, Swiss policy to promote public research and innovation entails public financial support, which in the environmental field focuses on upstream research (basic and applied) and prototype development. Public financial support is extended to pilot experiments for innovation in the field of energy (FOEN, 2017). Restriction on public support beyond the prototype phase relates to the private sector subsidiarity principle that typically defines the boundaries of public support in Switzerland.

A technology fund established by the CO_2 Act and funded by the CO_2 tax (with partial earmarking capped at CHF 25 million a year) (Section 3) is a notable exception. It provides

loan guarantees to companies that develop and bring to the market innovative products and processes that reduce GHG emissions, use renewables and are resource efficient. The fund secretariat has been handed over to private entities (Emerald Technology Ventures and South Pole Carbon), consistent with the Swiss approach of promoting collaboration and synergies with the private sector.

In terms of environmental public R&D as a share of total public R&D, Switzerland ranks last among OECD countries (Figure 3.7) (OECD, 2016g, 2015f). The share significantly decreased in the 1990s to a critically low level and has not picked up since (OECD, 2017a). This seems to contradict objectives of the 2013-16 and 2017-20 environment and energy master plans and the 2011-14 cleantech master plan.

Figure 3.7. **Environmental public R&D (% of total public R&D) needs to be reprioritised**



Note: GBAORD is government budget appropriations or outlays for R&D, which include all appropriations (government spending) given to R&D in central (or federal) government budgets. Provincial (or State) government posts are only included if the contribution is significant. Local government funds are excluded.
Source: OECD (2017b), Green Growth Indicators 2017.

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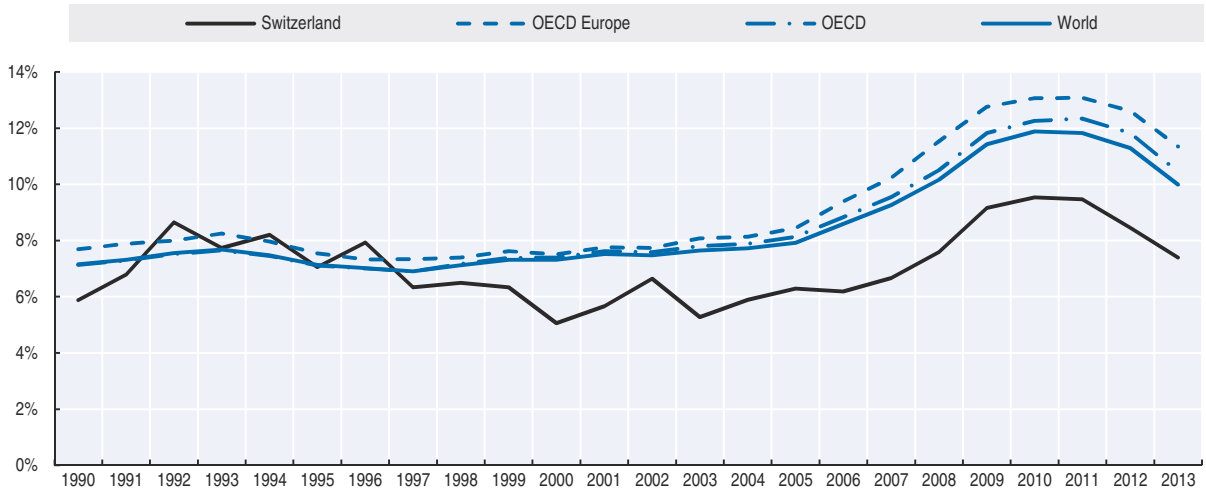
Further, patent data indicate that the share of environmental innovation in Swiss innovation has been lower than the OECD and OECD Europe averages since the mid-1990s (Figure 3.8). By contrast, Switzerland holds a better relative position on biotechnology, in terms of both public R&D investment and patent-related revealed technology advantage (OECD, 2014a).[9]

Public R&D policy has turned towards non-thematic research, to which Switzerland devotes the highest public financial support in the OECD (OECD, 2016g). Remaining thematic public R&D emphasises innovation on such leading industrial sectors as the pharmaceutical and chemical industries. Similarly, venture capital and private equity funding targets these industries more than clean technology. As a first step, public financial support for clean technology innovation could be increased at the pre-commercialisation stage (i.e. demonstration projects), as is the case for energy. Given the identified private finance gap, this would not necessarily contradict the principle of private sector subsidiarity.

Figure 3.8. **Environmentally related patents as percentage of all technology patents**



Note: Based on counts of priority patent applications (simple patent families), by inventor's country of residence, with patent family size of two or more (high-value inventions). Data for 2012 and 2013 are provisional.
Source: OECD (2017f), "Patents in environment-related technologies: Summary indicators", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571606

7.3. Promoting innovation by greening production and consumption

Despite the absence of R&D tax incentives (which typically catalyse private sector R&D investment), Switzerland has a very R&D-intensive business sector (OECD, 2014a). It is estimated that energy-related private R&D spending is about four times the size of public spending, going mainly to pilot and demonstration projects on energy efficiency (IEA, 2015). Research institutions must report on the extent to which Switzerland's sustainable development and environmental objectives have been considered in their research activities, under the 2014 Act on the Promotion of Research and Innovation. This can be considered significant progress in terms of mainstreaming sustainability and environmental concerns, and thus an overall greening of research activities.

Furthermore, the economy achieves above-average rates of product/process innovation among SMEs (OECD, 2015f), and of firms engaged in R&D with a close connection to end-use products and markets (OECD, 2014a). This would typically include eco-innovation relating to process and efficiency improvements that underpin Switzerland's leading performance on production-based productivity indicators (Chapter 1 and Section 1 of this chapter), but would be only very partially captured by patent counts and narrow sectoral definitions of clean technology.

Created in 2014, the Swiss Network for Resource Efficiency (Reffnet.ch) is a concrete example of non-patent-related innovation promotion. It helps companies (primarily SMEs), on a voluntary basis, find ways to reduce demand for raw materials while generating financial savings. Reffnet provides an in-depth evaluation of potential efficiency gains, along with plans and measures to achieve them. Close to 200 companies are using Reffnet, with about a quarter having committed to implementing improvement measures. Since its launch, Reffnet has led to the establishment of a pool of resource efficiency experts across the country.

As regards consumer behaviour, Switzerland has identified areas with high potential for improvement, including buildings (size and energy efficiency), vehicle ownership (which is

above the OECD average), food choice, consumption of high-quality/long-lasting goods and the carbon footprint of holiday travels (IED/EPFZ, 2009). Behavioural economics studies have been performed to better understand the circumstances in which consumers are most likely to change behaviour, what consumers look for in ecolabels and how to best design ecolabels (gfs.bern, 2010; IED/EPFZ, 2009). Health concerns and resource savings (e.g. energy, water) have been identified as leading motivations for consumers to purchase green products (gfs.bern, 2010).

There are many environmental labels of varying quality, which causes confusion among consumers despite the government-supported platform Labelinfo, which addresses the quality of each labelling system operating in the country. This challenge is not unique to Switzerland. The European Commission is developing and testing two labels (Product Environmental Footprint and Organisation Environmental Footprint), which would provide a uniform way to measure environmental performance across the European Union. Switzerland has participated in the EU working groups on coffee, detergents, T-shirts and non-leather shoes. This system would make it cheaper and easier for companies to comply with green product criteria and for consumers to make green consumption choices (European Commission, 2016). Actions to rationalise and increase ecolabel transparency should be strengthened, perhaps building upon the lifecycle-based Ecological Scarcity Method and the Ecoinvent inventory database developed in Switzerland (ESU-services, 2010), but will need to be closely co-ordinated with international initiatives, especially at the EU level.

8. Environment, development co-operation and trade

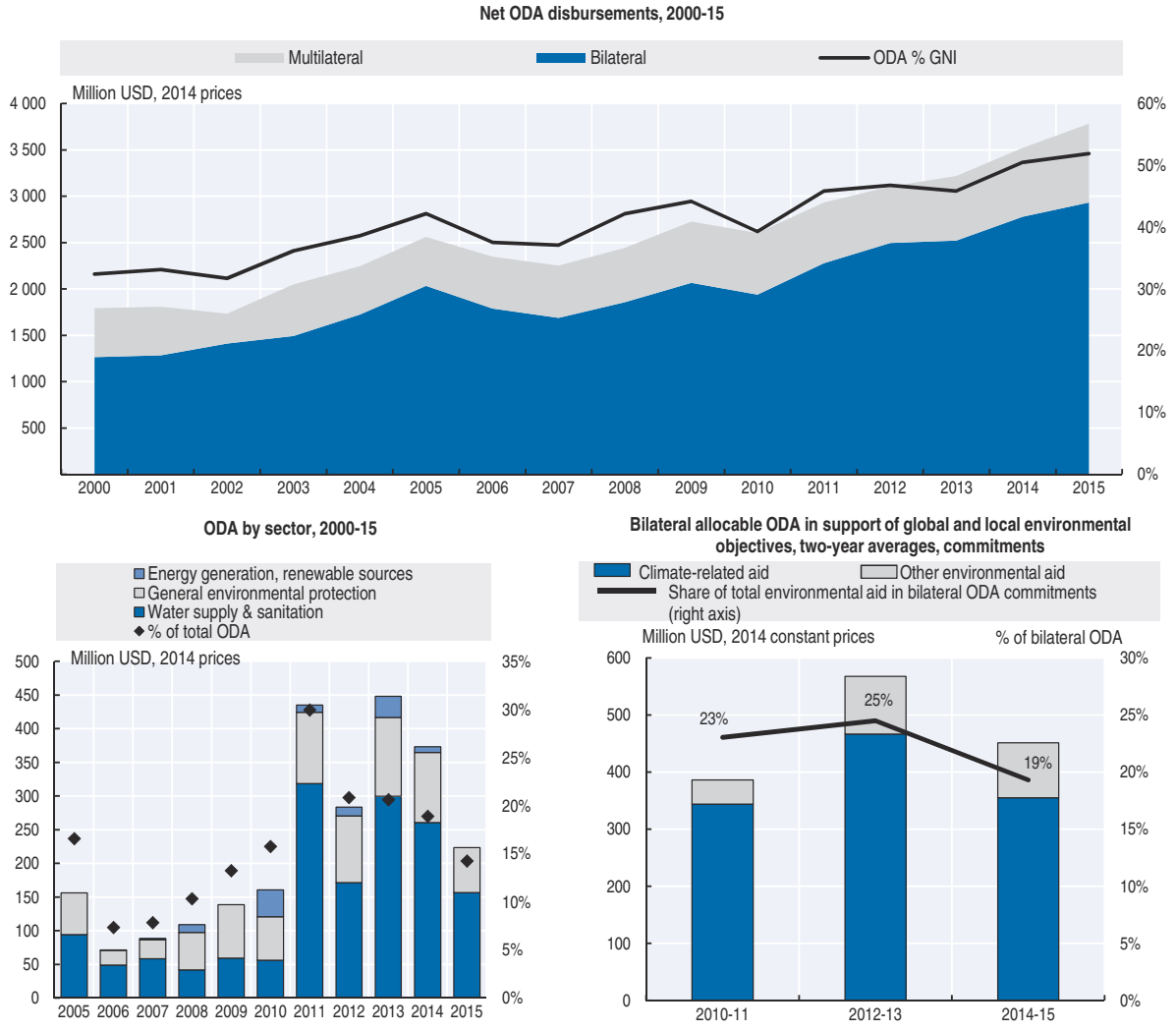
8.1. Mainstreaming environmental considerations in development finance

Switzerland contributes to developing countries meeting the Sustainability Development Goals, including environment-related ones, by providing official development assistance (ODA). In 2016, Switzerland was the 8th largest ODA provider among the 29 members of the OECD Development Assistance Committee (DAC) in terms of percentage of gross national income (GNI), and the 12th by volume. Net ODA disbursements in current prices have quadrupled since 2000 (and slightly more than doubled in constant prices), and Switzerland met the goal set by the Federal Assembly in 2011 of raising ODA to 0.5% of GNI by 2015 (Figure 3.9), though this is still below the United Nations target of 0.7%.

Switzerland's environment-related bilateral ODA increased strongly over the review period, peaking at 18% of total bilateral ODA in 2012 (Figure 3.9), though it has been on a decreasing trend since then and remained well below the OECD DAC average of 33.2% in 2015. Growth has been particularly rapid in water supply and sanitation. In 2014, Switzerland was the third largest DAC provider of bilateral environment-related ODA in this sector, after France and Slovenia. Water is one of four global programmes that the Swiss Agency for Development and Co-operation (SDC) established in 2008. Bilateral ODA on water aims to secure equitable and sustainable water management, and to ensure that human rights to water and sanitation are respected (SDC, 2013a). Switzerland also emphasises agriculture and rural development in environment-related ODA more than its DAC peers.

Switzerland has committed USD 100 million to the Green Climate Fund, the equivalent of USD 12.21 per capita, ranking 9th among the 30 countries pledged to the fund. As of 17 October 2016, 65% had been disbursed, putting Switzerland behind countries such as Belgium, Canada and Italy, which have disbursed 100%, but ahead of countries that have pledged more per capita, such as France and the United Kingdom (GCF, 2016). Switzerland

Figure 3.9. **Growth in ODA and in mainstreaming of environmental considerations**



Note: The bottom two charts refer to commitments.
Source: OECD calculations based on OECD (2017d), *OECD International Development Statistics* (database).

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has in addition committed USD 6 million to the Least Developed Countries Fund to support adaptation projects and national adaptation processes in LDCs (OECD, 2016h). Regarding private sector finance, it intends to increase the climate transparency of its financial markets and enhance mobilisation of private sector flows but has not yet laid out a strategy and concrete action plan to this end.

Switzerland has taken steps to develop a coherent approach towards integrating environment into development co-operation programming and projects, and has tools and mechanisms to support this. Co-operation between the SDC, SECO and FOEN is facilitated through a common platform on environment-related international financing and development co-operation, known as PLAFICO; established in 2012, it has likely contributed to an increase in environmental mainstreaming. Another example of such inter-agency co-operation is the platform on Renewable Energy and Energy Efficiency Promotion in International Co-operation (REPIC), a partnership established in 2004 between SDC, SECO

and SFOE. In 2012, the SDC developed Climate, Environment and Disaster Risk Reduction Integration Guidance to foster a coherent approach to flood and drought management in development strategies, programmes and projects (CEDRIG, 2015).

Climate change is also a major focus of Swiss development co-operation and the subject of an SDC global programme (SDC, 2014a; SDC, 2014b). Over 2010-14, 80% to 91% of environment-focused bilateral ODA targeted climate-related objectives, in particular climate change adaptation. In the context of the UN Framework Convention on Climate Change, Switzerland pledged CHF 140 million of new and additional climate finance from public sources over 2010-12 as part of the international Fast Start Finance agreement. By the end of 2012, 100% had been allocated to adaptation, forests and energy in 51 countries, and 75% disbursed (SDC, 2013b).

Environment and climate change constitute one of five thematic priorities for SECO, meaning all its investment must undergo environmental screening. Even so, the 2013 OECD Development Co-operation Peer Review of Switzerland identified a need to continue to closely monitor environmental mainstreaming in development policies (OECD, 2014). In this context, the inter-agency co-operation initiated in 2012 should be further pursued to strengthen a shared and coherent approach to increasing and monitoring environmental mainstreaming.

Like many OECD countries, Switzerland capitalises on synergies between environment-related technology transfer and knowledge transfer to developing countries and support for Swiss enterprises. For example, Swiss Bluetec Bridge provides zero-interest loans of up to 50% of project cost to Swiss start-ups, SMEs and social entrepreneurs to transfer technology and knowledge related to water supply and sanitation and water use efficiency in agriculture. Rural areas are prioritised. REPIC finances up to 50% of renewables-based and energy-efficiency projects in developing or transition economies that draw upon Swiss know-how. While REPIC projects have achieved relatively low CO_2 reductions, the programme has been particularly effective in terms of knowledge building and transfer (REPIC, 2016).

8.2. Trade and export credits

Ensuring coherence between Switzerland's trade and environmental policies is of utmost importance given the reliance of the economy on imports and exports of goods and services (OECD, 2015a). At least half the environmental impact of Swiss final domestic demand is estimated to occur in countries that export to Switzerland (Frischknecht et al., 2014). Switzerland is second to Luxembourg in terms of share of imported CO_2 emissions in total emissions embodied in final demand, with over a third of imported CO_2 emissions originating in non-OECD countries (Wiebe and Yamano, 2015). Furthermore, Switzerland has below OECD average shares of imports and exports of environment-related products as percentage of total imports and exports, both having decreased significantly between 2002 and 2015 (OECD, 2016i).

The 2013 GEAP assigned SECO, in consultation with FOEN, the task of evaluating the environmental impact of trade agreements (FOEN, 2013). A comparative evaluation of Swiss and Chinese environmental legislation was performed prior to the entry into force of the bilateral free trade agreement in 2013. In 2016, however, a report on GEAP implementation revealed that although opportunities to do so had arisen, no further trade agreement had been subject to SECO evaluation since 2013. SECO intends to decide whether to undertake

such evaluation case by case (Swiss Confederation, 2016). This should be much more systematic, however, rather than relying on ad-hoc considerations. The yet-to-be-negotiated free trade agreement between MERCOSUR and the European Free Trade Association (Iceland, Liechtenstein, Norway and Switzerland) provides an opportunity to make such an evaluation.

Since 2014, Switzerland has been one of the 17 World Trade Organization parties negotiating an environmental goods agreement aiming to liberalise trade on a range of goods of importance for environmental protection and climate action. Such engagement is consistent with Switzerland's international policy objectives of environmental integrity[10] and of promoting its clean technology exports. Promotion of such exports was initially (2010-15) conducted via the Cleantech Switzerland foundation; since 2016 it has been under Switzerland Global Enterprise, which has a broader export promotion mandate (the REPIC and Swiss Bluetec Bridge programmes mentioned in the previous section are additional examples).

The official export credit agency, Swiss Export Risk Insurance (SERV), participates in the OECD Arrangement on Officially Supported Export Credits. Hence, eligibility of Swiss export projects for export credit is conditional upon undertaking a sustainability assessment based on the OECD Common Approaches for Officially Supported Export Credits and Environmental and Social Due Diligence (OECD, 2016j), OECD anti-corruption guidelines (OECD, 2006) and the OECD guidelines to promote sustainable lending to low-income countries (OECD, 2016k). SERV may grant preferential credit terms for Swiss exports related to renewables, climate protection and water under the OECD Climate Change Sector Understanding (CCSU). In the absence of publicly available data, however, it is unclear to what extent SERV has put this instrument into practice. Furthermore, export credit agencies are demand driven and thus typically do not proactively seek to increase the share of CCSU activities in their portfolio.

Recommendations on green growth

Green economy framework

- Further strengthen inter-office collaboration to promote GEAP as a whole-of-government approach; foster coherence of GEAP with relevant plans and strategies, e.g. Energy Strategy 2050, Action for Corporate Social Responsibility, Sustainable Development Strategy.

Greening the tax and incentive system

- Consider ways to widen the CO_2 tax base and strengthen efforts to align sectoral and macroeconomic policies for a low-carbon economy; this should include the phasing out of remaining tax exemptions and rebates for fossil fuel consumption, including to free budgetary resources for further developing renewables and improving energy efficiency.
- Expand incentive-based taxation to reduce the environmental impact of consumption; in particular, consider introducing mobility pricing and making the bin-liner fee an incentive-based instrument rather than one aimed at recovering the costs of MSW disposal.
- Pursue efforts to make direct payments to farmers linked to the provision of well-identified and otherwise unremunerated public goods and services as a means of contributing to absolute decoupling between agricultural production and the environmental performance of agriculture.

Recommendations on green growth *(cont.)*

Public investment in support of a greener economy

- Maintain or strengthen the polluter-pays principle to finance needed investment (e.g. in sewage treatment plants) due to ageing of environmental infrastructure, population growth and urbanisation, via an increase in corresponding charges, as necessary to ensure cost recovery.
- Further adjust the conditions for benefiting from support to changing market conditions in order to optimise the cost of the transition from nuclear power to renewables; for instance, applicants could be required to demonstrate that their investment would not be made in the absence of support.
- Ensure that earmarking of ERT revenue is bound to defined objectives and periods; the reliance of support to renewables and the energy efficiency in buildings programme on earmarking (of the grid tax and CO_2 tax, respectively) should, for instance, be reduced over time in order to increase flexibility of tax revenue allocation based on changing market conditions and spending needs.

Mobilising the corporate and financial sectors

- Take concrete steps to more systematically monitor, and create incentives for improvement in, the environmental performance of investments made by the financial sector; exclusion of environmentally harmful (e.g. fossil-fuel-related) activities from asset holdings and mandatory disclosure regarding the alignment of financial flows with international climate agreements could initially be implemented and tested with publicly owned entities, then progressively rolled out, which could significantly speed the sensitisation of the financial sector, leading to behaviour change at scale.
- Public-private partnerships between federal or subnational authorities and the financial sector could be further explored to mobilise private finance for greener infrastructure investment in renewables, energy efficiency and sustainable transport.

Fostering eco-innovation

- Take better advantage of Switzerland's world-leading strengths in research and innovation to reposition the country as a front runner in eco-innovation; concrete steps could include rejuvenating public support for eco-innovation, especially in the demonstration and early commercialisation phases, for which the well-working Swiss venture capital market could be better utilised.

Mainstreaming environment in development co-operation and trade

- Maintain, and consider strengthening, the common platform on international financing and development co-operation regarding the environment as a key enabler for Switzerland to meet its international ODA-, climate- and biodiversity-related financial commitments.
- Make evaluation of the environmental impact of any new trade agreement a requirement rather than relying on ad-hoc considerations; the yet-to-be-negotiated free trade agreement between MERCOSUR and the European Free Trade Association (which includes Switzerland) provides an opportunity to do so; in addition, consider options for greening the Swiss export credit agency's portfolio.

Notes

1. The weight-based part aims to compensate for compaction damage to the road rather than for diminished air quality.
2. In 1989, an NGO called Alpine Initiative launched a popular initiative "for the protection of the Alpine region from transit traffic". Also known as the Alpine Initiative, it was accepted in 1994 by a majority of both the Swiss people and the cantons.
3. Switzerland imports two-thirds of its oil products from refineries in Belgium and the Netherlands.
4. Emission reduction (Kyoto) certificates yielded by the Climate Cent Foundation projects abroad were handed over to the Confederation free of charge.
5. The increase from the first commitment period (the cap was 3.42 Mt CO_2 eq in 2012) is mainly explained by the inclusion of additional sectors (refineries) and GHGs (geogenic CO_2 emissions).
6. Based on property valued and levied by 19 of the 26 cantons.
7. There is no residential tax. Instead, municipalities levy part of the income tax through a communal tax whose rate varies greatly by municipality.
8. Outward FDI stock is the value of resident investors' equity in and net loans to enterprises in foreign economies. Outward FDI flows represent the net effect of transactions that increase (decrease) the investment that investors in the reporting economy have in enterprises in a foreign economy, such as through purchases (sales) of equity or reinvestment of earnings (borrowing) by the resident investor from the foreign enterprise.
9. The revealed technology advantage index is calculated as the share of a country in patents filed in a given field relative to the share of the country in total patents. For further information and data, see *www.oecd.org/sti/inno/oecdpatentdatabases.htm*.
10. Under the UNFCCC, Switzerland takes part in the Environmental Integrity Group, formed in 2000, which also includes Mexico, Liechtenstein, Monaco and Korea.

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PART II

Progress towards selected environmental objectives

PART II

Chapter 4

Water management

Switzerland has embarked on a long-term endeavour to rehabilitate its rivers to their natural functioning and counteract continued aquatic biodiversity loss. It is one of the first countries implementing a national policy to reduce micro-pollutants in municipal sewage treatment plant effluents, and new measures are being considered to tackle diffuse pollution from agriculture. Enforcing protection of groundwater abstraction areas, the main source of drinking water, is an emerging issue. This chapter assesses Switzerland's performance in these four areas. It also reviews the state of water quality and the main pressures on water resources.

1. Introduction

On the basis of Article 76 of the Federal Constitution, which lays down the general principles for water resource management, Switzerland has enacted federal laws concerning hydropower, water protection and flood protection:

- The 1916 Act on Hydropower Use regulates the rights of disposition and use and the granting of water use rights. The cantons hold discretionary power over the use of hydropower.
- The 1991 Waters Protection Act (WPA) aims at safeguarding water quality, maintaining adequate residual flows and preventing harm to waters. As amended in 2011, the law also requires the cantons to provide sufficient space for waters (the land involved can only be farmed to promote biodiversity) and to rehabilitate priority watercourses. The 2011 amendment also requires hydropower plant operators to reduce hydropeaking,[1] sediment transport changes and fish migration obstacles resulting from their activity (the so-called "ecological improvement" of installations related to hydropower use) by 2030.
- The 1991 Watercourse Management Act (WMA) aims to protect people and important material assets from flooding, erosion and aggradation.[2]

Switzerland adheres to the principle of subsidiarity and gives the cantons a high degree of autonomy. The cantons have the main authority over water resource management: they are responsible for issuing water use licences and concessions, except where water is abstracted in transboundary waters (in which case the Confederation has jurisdiction). They are also responsible for flood protection and WPA enforcement. Water supply and sanitation services are municipal responsibilities but governed by federal legislation. The country's 236 water utilities[3] are self-monitoring, with cantonal oversight. There are no private water utilities, but management principles in use are often inspired by the private sector.

Switzerland has adopted a pragmatic approach to watershed management. Some cantons have introduced it into their legislation. The 2011 amendment to the Water Protection Ordinance (WPO) requires co-ordination of water management activities, in some cases explicitly within a watershed (Box 4.1).

Box 4.1. **Towards watershed management**

The 2007 OECD Environmental Performance Review (EPR) recommended promoting integrated water basin management. This has partially been achieved. A National Working Group on Integrated Watershed Management was created in late 2008. The work of this group led to the publication, in 2011, of a set of guidelines on the principles of watershed management for cantonal, regional and municipal actors. In 2013, FOEN published a practical guide to clarify how to apply the principles set out in the guidelines, as well as an enforcement aid on co-ordination of water management activities, as required by the 2011 WPO amendment (Article 46). The aid lays out a three-step "co-ordination principle" showing how to identify when co-ordination is necessary, co-ordinate activities within a watershed and determine requirements for the relevant authorities.

Box 4.1. **Towards watershed management** *(cont.)*

As part of the National Research Programme on Sustainable Water Management (NRP 61 of the Swiss National Science Foundation), the interdisciplinary research project "Integrated Water Policy with Adaptive Capacity in Switzerland" provides practical tools and examples on assessing and responding to institutional issues related to integrated water management. The tools are particularly aimed at cantonal and municipal authorities.

Recent water policy measures that can be considered consistent with river basin management include river rehabilitation work (Section 4.3), insofar as it seeks to maintain river system continuity; and actions related to Switzerland's upstream responsibility to keep micro-pollutants from being exported to neighbouring countries' coastal waters (Section 4.1).

2. State of water quality

2.1. Surface water quality

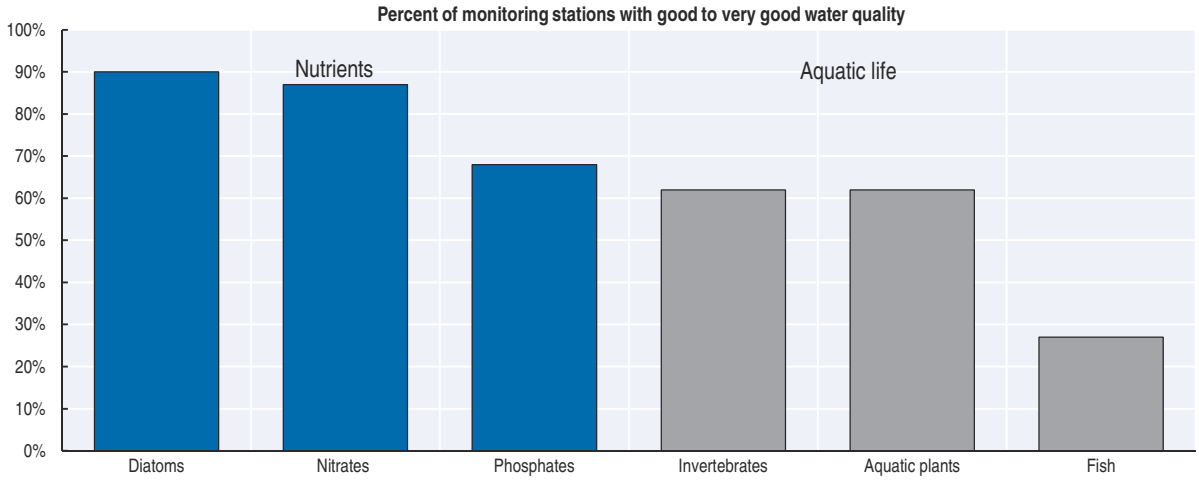
The 2007 EPR recommended harmonising federal and cantonal water quality monitoring. This has partially been achieved. Since 2011, the Confederation and the cantons have jointly run the National Surface Water Quality Monitoring Network (NAWA) to evaluate water body quality on a national level. However, the network does not recover all information available in the cantons. The cantons have many more monitoring stations than those available to NAWA, which they use in implementing cantonal legislation. NAWA's scope should be extended to small rivers, which account for 75% of the hydrographic network, and to analysis of micro-pollutants, which are monitored only in specific observation campaigns.

NAWA monitoring between 2011 and 2014 revealed that the state of watercourses was mixed: nutrient loads (phosphorus and nitrogen) were reduced overall but not everywhere, and micro-pollutants are an emerging concern, as is biological status. Most watercourses are of satisfactory quality when it comes to nutrient loads, but the proportion decreases to some 60% for biological water quality, and only a quarter of rivers have sufficient water quality for fish (Figure 4.1). Unsurprisingly, rivers of the Swiss Plateau (the most densely populated region, covering about 30% of Switzerland[4]) are more polluted than others. As a rule of thumb, the higher the proportion of urbanised areas (and thus of urban sewage), the worse the water quality. Poor water quality is also correlated with poor ecomorphological conditions, and NAWA has revealed that small rivers are particularly polluted.

Despite progress in recent decades, nutrient concentrations are still too high at almost 10% of the 111 NAWA stations, particularly in watercourses with a high proportion of insufficiently diluted treated sewage and those crossing areas of intensive agriculture. Medium-sized and small watercourses are particularly affected. Small rivers – breeding grounds for many fish and refuges for small organisms – are particularly polluted in agricultural areas (by nutrients and pesticides). Moreover, Switzerland exports too much nitrogen to the North Sea via the Rhine, contravening its commitments under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), though it has fully met the objectives set by the International Commission for the Protection of the Rhine for the quality of the Rhine waters in the Basel region.

Half of the 20 largest Swiss lakes still suffer from eutrophication and lack of oxygen, some to the point of having to be artificially ventilated (Table 4.1). Lakes in areas of intensive livestock farming or with many plots of open land[5] (e.g. Lakes Lugano and Zug) are particularly affected.

Figure 4.1. **Surface water quality (2011-14): status is mixed**



Note: Diatoms are an indicator of nutrient pollution. Aquatic life is not monitored in small rivers.
Source: FOEN (2017a), « Pour une meilleure qualité de l'eau ».

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Table 4.1. **Eutrophication affects water quality in many large lakes**

Lake	Phosphorus content for maximum average production	Dissolved oxygen limit met (> 4 mg O_2/l)	Trophic status[1]	Need to reduce nutrient inputs from	
				Agriculture	Sewage treatment
Eight Lakes[2]	Y	Y	Oligo	N	N
Léman (Geneva)	Y	N	Oligo	N	N
Zurich	Y	N	Meso	N	Y
Pfäffikon	Y	N (ventilated 1992-2001)	Meso	N	Y
Biel and Joux	Y	N	Meso	Y	Y
Baldegg	Y	N (ventilated since 1982)	Meso-eutro	Y	N
Hallwil	Y	N (ventilated since 1985)	Meso-eutro	Y	N
Sempach	Y	N (ventilated since 1984)	Meso-eutro	Y	N
Greifen	N	N (ventilated since 2009)	Eutro	N	Y
Lugano, Murten and Zug	N	N	Eutro	Y	Y

1. A eutrophic ("well-nourished") lake has high nutrients and high biomass production. An oligotrophic lake has low nutrient concentrations and low biomass production. Mesotrophic lakes fall somewhere in between.
2. Ägeri, Brienz, Constance, Lucerne, Maggiore, Neuchâtel, Thun and Walen.

Source: FOEN (personal communication).

The eutrophication of small lakes is particularly alarming and has tended to deteriorate over the past decade, as for example in Bern canton (Table 4.2). Unlike large lakes, small lakes have seen no significant decrease in nutrient inputs, and do not meet the 2011 WPO requirement for dissolved oxygen (where applicable). Nutrient inputs come mainly from agriculture (most of the small lakes affected are located in agricultural watersheds) and from the release of phosphorus in sediment. Bern canton recommends improving fertiliser application practices, creating a buffer zone without fertiliser around lakes and preventing direct urban sewage discharge by technical means (see water drainage plans in Section 4.1).

Rivers' ability to preserve aquatic biodiversity (invertebrates, plants) – i.e. their biological status – is insufficient at least 30% of NAWA stations, and the state of fish populations is considered unsatisfactory at three-quarters of the sites monitored. In species that suffer

Table 4.2. **Small lakes in Bern canton suffer from poor eutrophication status**

Lake	Trophic status[1]			Depth			Summer/Fall hypoxia (% lake area)
	1998[2]	2003[3]	2013[3]	Summer/Fall hypoxia from (m)			
				Max (m)	2003	2013	
Burgäschi	Oligo	N.A.	Poly	30	9	7	70
Burgseeli	Meso	Poly	Poly	19	8	7.5	64
Dittlig	Meso	Poly	Poly	16	5	5.5	62
Uebeschi	Meso	Eutro	Poly	15	7	6.5	60
Moos	Meso	Eutro	Poly	21	8	8.5	60
Amsoldinger	Meso	Poly	Poly	14	7	6.5	57
Gerzen	Meso	Poly	Poly	11	7	6.5	54

1. In decreasing order of eutrophication: polytrophic, eutrophic, mesotrophic and oligotrophic. A polytrophic lake has a very high continually available nutrient content; deep water lacks oxygen in summer and is occasionally infiltrated by hydrogen sulphide; surface water is occasionally strongly saturated with oxygen; very low depth of visibility.
2. According to the phytoplankton biomass as measured by the LAWA index (named for the German acronym of the Working Group on Water Issues).
3. According to the phytoplankton composition, seasonal mean, as measured by the Brettum index (developed in Norway by Pål Brettum).

Source: Zeh (2015), *État des petits cours d'eau du canton de Berne: illusions et réalité*, *www.cercleau.ch/files/3014/3566/9961/Cercleau_2015_F_Zeh_Markus.pdf*.

particularly from waters' bad biological status, populations have decreased greatly over time. River development and hydropower contribute to biological deficiencies.

Another contributing factor is the presence of micro-pollutants such as drugs, plant protection products, heavy metals and biocides, which degrade poorly, if at all. Many micro-pollutants have been detected in NAWA observation campaigns, sometimes at levels harmful to aquatic organisms. Concentrations in lakes are also tending to increase. In many medium-sized to large watercourses, most micro-pollutants come from sewage treatment plants. A survey over the last ten years revealed that many watercourses also carried micro-pollutants from diffuse sources, which regularly cause ecotoxicological quality criteria to be exceeded, especially in small rivers. Agriculture and, to a lesser extent, urbanised areas are the main diffuse sources. The 2007 EPR recommended assessing and reducing micro-pollutant sources from urban areas, industry and agriculture. This has been done to some extent: Switzerland is a front runner in equipping treatment plants with micro-pollutant removal (Section 4.1), and an action plan is being prepared to tackle diffuse sources from agriculture (Section 4.2), though Switzerland lags behind the EU in this area.

The section of the River Doubs that forms part of the border between Switzerland and France shows signs of significant degradation: e.g. fish with mycosis, excess mortality after spawning, algal blooms. A bi-national governance structure was established in 2011 to address these water quality problems as well as flow management and fishing. In 2014, the Confederation, in collaboration with Neuchâtel and Jura cantons, developed a national action plan for the Doubs. The action plan aims to restore the ecosystems linked to the border Doubs and Jura Doubs, including to ensure survival of the Rhône Apron (*Zingel asper*), a fish species emblematic of the Doubs.

2.2. Groundwater quality

Nitrate concentrations above 25 mg/litre are found at almost 25% of National Groundwater Monitoring (NAQUA) stations, and 20% of stations record pesticide residues exceeding 0.1 µg/l (the respective shares are 60% and 70% on open land). NAQUA has been fully operational since 2005.

Volatile organic compound are found in concentrations greater than 1 µg/l at 8% of NAQUA stations. The share is 20% in the supply basins of urbanised regions.

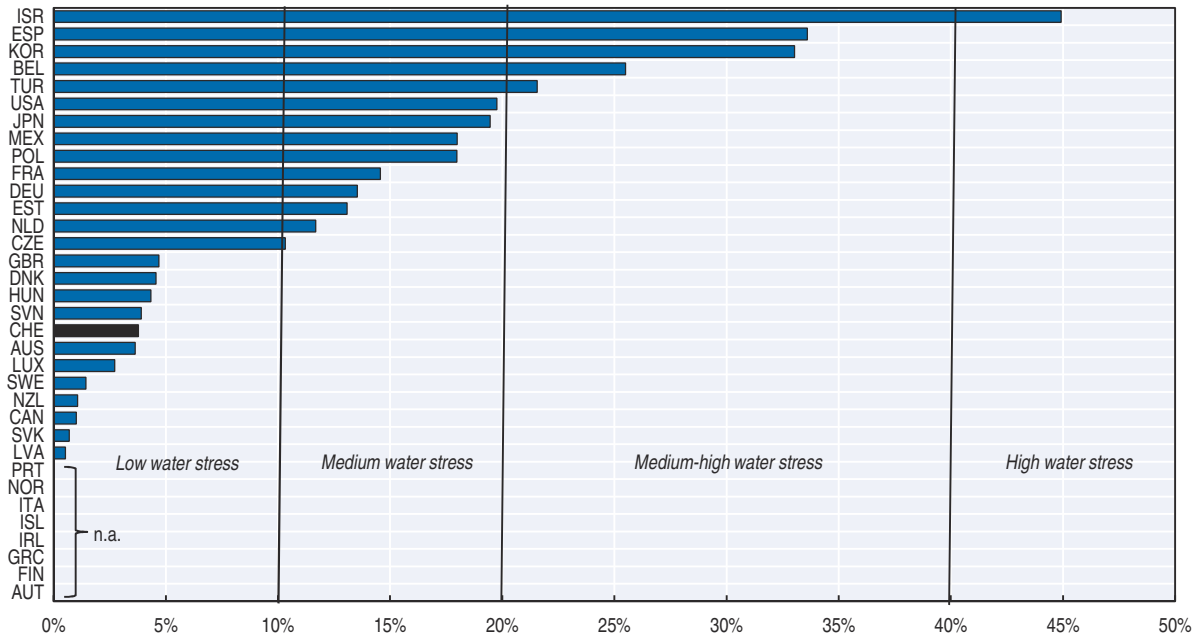
Residues of drugs and perfluorinated compounds have been detected at NAQUA stations near watercourses. They come mainly from sewage that enters waterways from sewage treatment systems, then contaminates groundwater via riverbank filtration.

3. Pressures on water resources

3.1. Artificialisation of watercourses

Switzerland, known as the "water tower of Europe" (it accounts for around 6% of the continent's freshwater), has significant water resources. Water consumption in households and industry has declined in recent decades despite population growth. With abstractions at 4.2% of renewable resources, Switzerland's water stress has remained low (Figure 4.2), although there are concerns in relation to protecting groundwater abstraction areas (Section 4.4).

Figure 4.2. **Freshwater abstraction as % of total renewable resources is relatively modest**



Note: Data refer to 2014 or the latest available year. They include provisional figures and estimates. For some countries, data refer to water permits rather than actual abstractions.
Source: OECD (2017a), "Freshwater abstractions", *OECD Environment Statistics* (database).

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Over time, however, land use intensification has profoundly altered the structure of watercourses over long stretches. Many streams and rivers have been developed or modified to meet increasing land requirements or protect populated areas from flooding. As a result, the space reserved for watercourses narrowed in many places, sometimes down to a drainage channel. This trend has been halted, as regulations now require water space lost to new river development to be offset elsewhere. The urban area grows by 25 km^2 a year, equivalent to 0.06% of the territory, mainly to the detriment of farmland. On the plateau,

where population density is high, pressure on forests is also increasing. The area reserved for water, as the WPA now defines it, is among sources of potential discord in land use decisions. It is precisely where the pressure from agriculture and urbanisation is greatest that the need for water rehabilitation is highest.

Mostly dyked, Swiss streams struggle to fulfil their natural functions. Sediment transport and fish migration are disturbed. More than 100 000 artificial barriers over 50 cm high on streams and rivers hinder the free upstream and downstream movement of fish in the Swiss hydrographic network. As a result of the numerous structures designed to protect against floods, produce energy and gain land for agriculture or building, nearly a quarter of the total length of Swiss rivers (15 000 km out of 65 000 km) have a poor ecological structure. For about 4 000 km of the 15 000 km of dyked watercourses, rehabilitation measures are planned over a period of about 80 years (i.e. by about 2090). Some 52% of watercourses with artificial structures are found in large Alpine valleys at less than 600 m altitude; by contrast, outside of large valleys and above 600 m in the Alps, the share is only 15%. It reaches 38% on the Swiss Plateau, 36% in the Jura.

Hydropower production influences river flows and causes structural changes in waters. In the early 1990s, for example, many streams and rivers were regularly dry downstream of water diversion by run-of-river plants. When producing peak energy, electricity generation by impoundment[6] causes hydropeaking downstream of the reservoir, which significantly alters the water level, velocity and width of the watercourse, as if it were in flood.

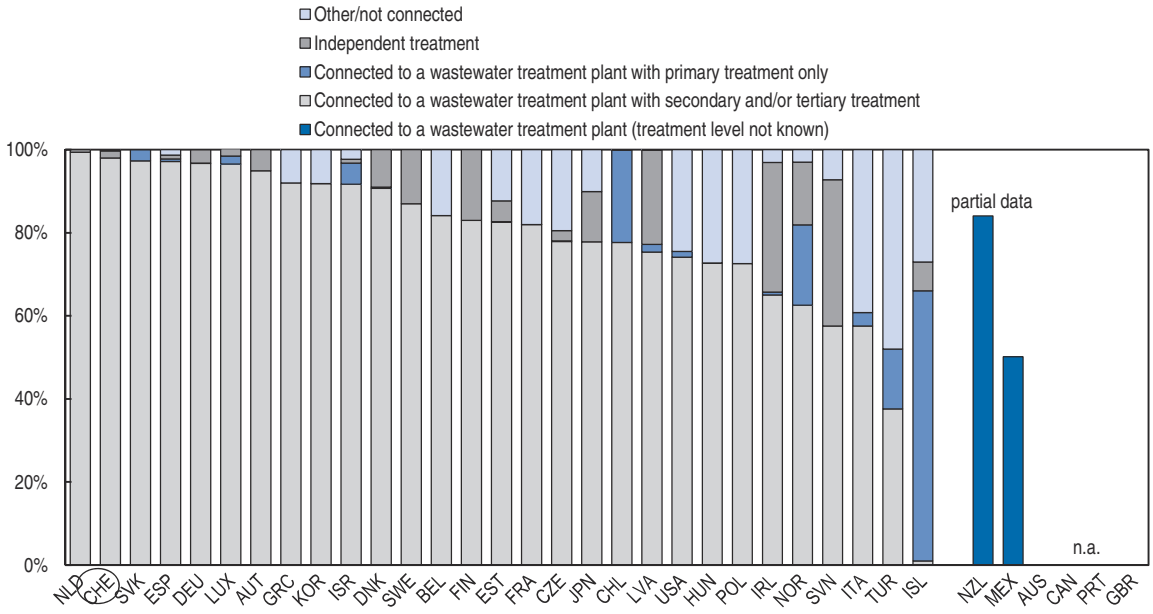
3.2. Sewage and micro-pollutants

Micro-pollutants can worsen water quality even in trace concentrations. In response to the Hêche postulate,[7] the Federal Council is preparing a report on opportunities to further reduce micro-pollutant inputs into surface waters and groundwater at source. In the meantime, consistent with a risk approach, Switzerland is committed to ensuring that almost half of sewage undergoes quaternary treatment (micro-pollutant removal), since conventional primary, secondary and tertiary treatment does not remove all micro-pollutants (Section 4.1).

Sewage treatment is at a very high level: 97.3% of the population is connected to a treatment plant, a level second only to that of the Netherlands among OECD countries (Figure 4.3). An additional 1% can be connected without entailing excessive cost, but plans call for the rate of connection to increase only slightly over the next few years. The remaining 2% of the population, generally in remote rural areas that cannot be connected to the public network, uses decentralised systems (septic tanks).

Switzerland plans to continue increasing the share of sewage treatment plants achieving tertiary treatment (nutrient removal) until 2040. After decades of continuous improvement (Figure 4.4), tertiary's share now represents 70% of sewage treatment: 34% with full nitrogen removal and 36% with partial nitrogen removal. However, treatment plants still release 23 000 tonnes of nitrogen per year into watercourses, while eliminating 20 000 tonnes. Use of best available techniques would allow plants to eliminate an additional 6 600 tonnes. The spread of built surfaces and related soil sealing form an additional problem. Increasing soil waterproofing makes more rainwater flow on the surface instead of infiltrating the ground, posing a risk of overflow in unitary networks (those transporting both rainwater and sewage).

Figure 4.3. **Switzerland is No. 2 among OECD countries in population connected to sewage treatment plants**



Note: Data refer to 2015 or the latest available year. They include provisional figures and estimates. Other treatment has been reallocated to secondary/tertiary or to primary according to the relative share of total treatment.
Source: OECD (2017c), "Wastewater treatment (% population connected)", *OECD Environment Statistics* (database).

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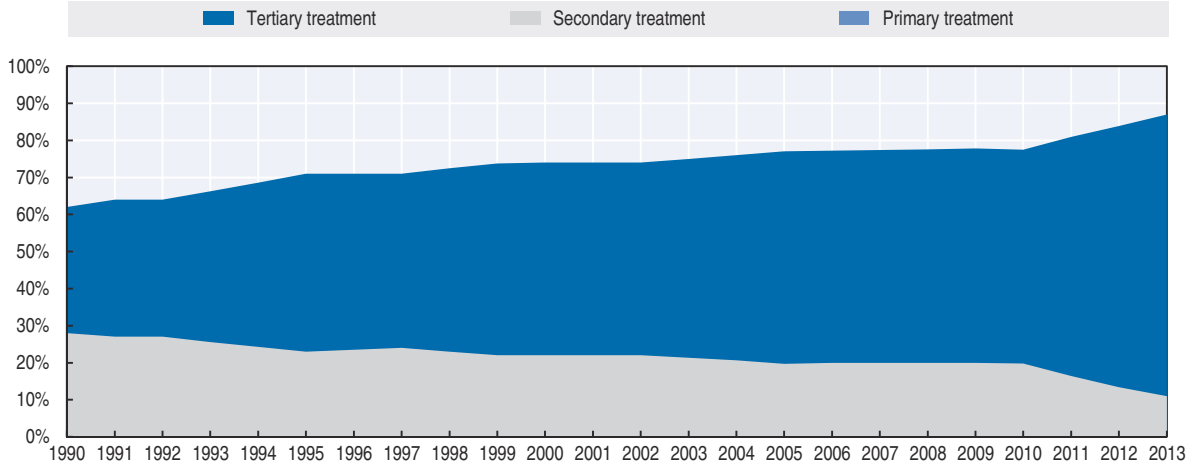
Figure 4.4. **Some 70% of sewage treatment is tertiary and the share continues to grow**



Note: Data include estimates.
Source: OECD (2017c), "Wastewater treatment (% population connected)", *OECD Environment Statistics* (database).

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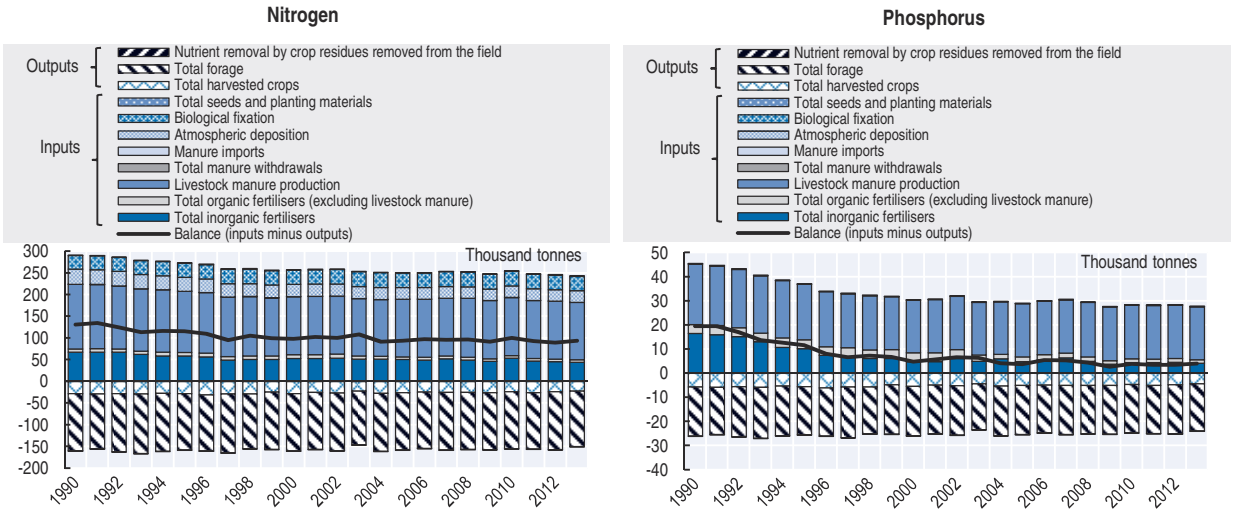
3.3. Agricultural nutrients and pesticides

In 2002, the Confederation set intermediate agri-environmental targets for 2005 (from a 1990-92 baseline), including reducing nitrogen surpluses by 23%, phosphorus surpluses by 50%, pesticide use by 32% and ammonia emissions by 9%, and dedicating 10% of farmland to areas for biodiversity promotion (OECD, 2015b). Other targets were for 98% of farmland to be

cultivated according to ecological compliance or organic farming standards and 90% of drinking water in agricultural areas to have a nitrate level below 40 mg/l. Almost all targets were met, except nitrogen surpluses, which have remained little changed since 2000, and the introduction of ecological direct payments and environmental cross-compliance and of the compulsory farm nutrient management plan (Figure 4.5).[8] In contrast, phosphorus surpluses declined sharply after the introduction of direct payments in 1993, to 2 kg/ha of agricultural land, on average, in 2011-13. Pesticide sales have remained little changed over the last decade, at around 2 200 tonnes per year. Switzerland ranks in the middle of OECD countries for intensity of agricultural pesticide use (Figure 4.6).

Figure 4.5. **The nitrogen balance is little changed but phosphorus has declined**



Note: Data reflect OECD methodology.
Source: OECD (2017b), *OECD Agriculture Statistics* (database).

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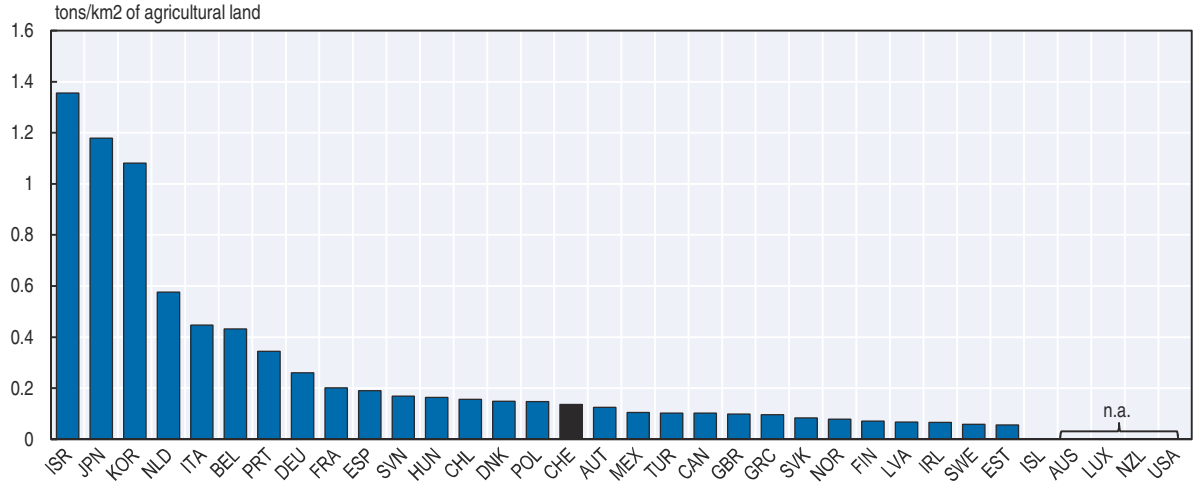
Figure 4.6. **Agricultural pesticide use intensity is about average**



Note: 2010-2014 average (or available years).
Source: FAO (2016), *FAOSTAT* (database).

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In 2008, the Federal Office for the Environment (FOEN) and Federal Office for Agriculture (FOAG) jointly published new environmental targets for the agricultural sector. Based on existing legal requirements, they cover biodiversity, landscape and space for waters, climate and air, water, and soil. Since then FOAG has routinely monitored progress towards meeting the targets, using a survey of 17 agri-environmental indicators on 300 farms. A progress report released in 2016 forms the basis for the Federal Council's response to the Bertschy postulate.[9] The survey result is worrying, as none of the water-related targets have fully been met (Table 4.3). Further efforts are required in agricultural catchments to provide space for waters and tackle nutrient and pesticide contamination.

Table 4.3. **Further efforts are needed on compliance with water-related agri-environmental targets**

Agri-environmental target	Achievement of the target	
	State in 2016	Outlook under business as usual (according to FOEN and FOAG)
Space for waters in agricultural catchments		
Sufficient space for watercourses	Not met (deadline is 2018)	2011 amendment of WPA clarified legal requirements but direct payments to farmers (under WPA Article 62b) may not suffice
Water quality in agricultural catchments		
Maximum 25 mg/l of nitrates in water intended for human consumption[1]	Not met everywhere; 45% of NAQUA stations on cropland and 14% on grassland exceed the limit	Better enforcing the WPA should further reduce nitrate inputs, as should technical and organisational measures; it is too soon to assess the possibility of meeting the target
50% reduction (from 1985) in agricultural nitrogen inputs to water	Not met (25% reduction so far)	Decreasing ammonia emissions will reduce nitrate inputs to aquatic ecosystems but it is difficult to be sure that agricultural inputs of nitrogen will be further reduced
Minimum 4 mg/l of dissolved oxygen in lakes at any time and any depth	Met in large lakes except Baldegg, Sempach, Hallwil, Biel, Zug and Murten; no overview for small lakes	Improved WPA enforcement and better consideration of phosphorus reserves in soil should further reduce phosphorus inputs
Avoid environmental and health damage from pesticides used in agriculture Maximum 0.1 µg/l pesticides in water and WPO ecotoxicological requirements Reduce environmental risks from pesticides	Not met for environmental damage; no indications of health damage Largely met in exploited groundwater; often not met in small and medium-sized rivers Not met	A pesticide action plan is required (Section 4.2), as is rigorous control of pesticides on the market; it is too soon to assess the possibility of meeting the target

1. The WPO (under FOEN) sets a limit for nitrates in groundwater used as drinking water at 25 mg/l while the limit for nitrates in drinking water is 40 mg/l, set in the Ordinance on Foreign Substances and Components in Foodstuffs (under the Federal Department of Home Affairs).

Source: FOEN and FOAG (2016), « Objectifs environnementaux pour l'agriculture – Rapport d'état 2016 », *Connaissance de l'environnement*, 1633, *www.bafu.admin.ch/dam/bafu/fr/dokumente/biodiversitaet/uw-umwelt-wissen/umweltziele_landwirtschaftstatusbericht.pdf.download.pdf/umweltziele_landwirtschaftstatusbericht.pdf*.

Biodiversity promotion areas[10] aim at biodiversity conservation on farmland. By reducing intensification of agricultural production, they also help decrease farm input use. The areas expanded from 2% of farmland in 1993 to 15% in 2015 (Chapter 5). They are equally distributed between lowlands and mountains; over 85% of their combined area consists of extensive (and low intensity managed) meadows.

3.4. Climate risk

A national research programme (NRP 61) carried out between 2008 and 2014 assessed, among other things, water risk resulting from socio-economic change and climate change in the coming decades (Comité de direction du PNR 61, 2015). NRP 61 was a comprehensive

effort involving 16 research projects, with a four-year budget of CHF 12 million. It found that, in general, Switzerland will have enough water in the future. However, lower summer precipitation and reduced snowmelt may result in more frequent water shortages in the Alpine regions at certain times of the year.[11] In high mountain areas, climate change will be rapid and visible: almost 90% of the volume of Swiss glaciers will have melted by the end of this century.[12] The glaciers will have retreated above 4 000 m altitude. Hundreds of small lakes, and some larger ones, will appear in the mountain regions. They will be a source of danger for people but also offer opportunities for tourism and hydropower generation. Hot, dry summers with low precipitation will be more frequent. Some regions may even experience water scarcity. Summer drought and low water levels, as well as the resulting warming of watercourses, can be a real problem for the protection of aquatic environments and groundwater.

NRP 61 also looked at sectoral impacts on territorial development, agriculture, energy and tourism. Growing urbanisation will threaten drinking water supply from groundwater abstraction areas where compulsory protection zones and measures can no longer be guaranteed (Section 4.4). Climate change will lead to more frequent drought and irrigation water supply difficulties. It is more difficult to forecast the combined effects of water resource use and climate change river ecology. On the one hand, increased use of renewable energy sources will involve further reliance on rivers (to produce hydropower and cool thermal power plants) as well as groundwater and lakes, along with heat pumps for heating and air conditioning. On the other hand, climate change will affect available water volumes and increase water temperature. It will change the attractiveness of Alpine landscapes and could present risks for tourism. The number of hotels and other types of holiday accommodation, and thus the number of tourists, is increasing. As a result, water demand for drinking and for irrigating lawns and gardens will grow, especially in summer, while in winter skiing will require more artificial snow making.

Switzerland long felt no need to manage low water levels, but in recent years increased pressure on water resources has prompted it to develop strategies to manage the risks, mostly local, of low water, drought and water scarcity. The 2012 Federal Council report in response to the Walter postulate[13] presented the risks of low water, drought and water scarcity in detail. The postulate raised the issues of short-term events such as local water shortages and long-term challenges such as general scarcity of water resources, particularly as a result of climate change. To address such problems, the Confederation has proposed measures and developed guidelines for the cantons, such as the mapping of areas at risk of low water, drought and water scarcity.

In 2012, the Federal Council adopted the first component of its National Climate Change Adaptation Strategy. In 2014 it approved the second phase, as well as an action plan for 2014-19 including water management measures such as multipurpose reservoirs, adequate space for the rivers and river rehabilitation (Section 4.3), and river basin management. However, the plan focuses on drought risk, neglecting flood risk. Overall, cantons lack strategic priorities and proper co-ordination to respond to the climate change challenge. The conclusions (in 2014) of the Bases for Water Supply 2025 project also stress that the cantons need to know more about their water resources and better plan water use (FOEN, 2014). For example, the project recommends improving measures to protect water in cantonal land use planning, including to enhance water supply security. More generally, increasing water risk from climate change need to be factored in when weighing economic and environmental interest of development projects.

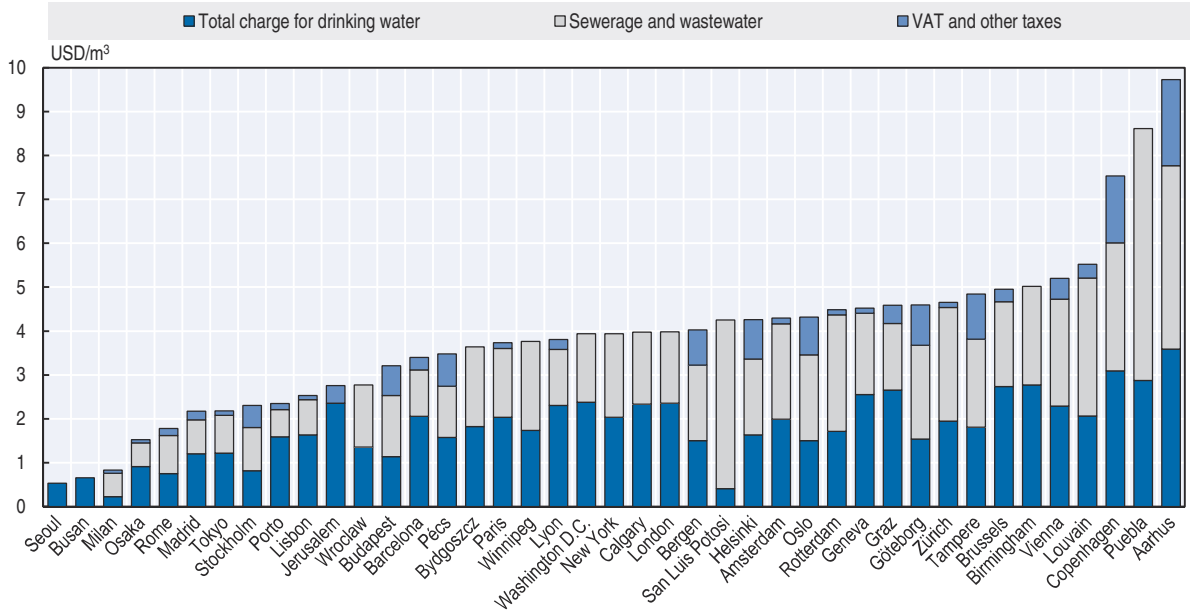
4. Policy response

4.1. *Urban sewage treatment and micro-pollutant removal*

Water pricing

There is a strong tradition of subsidiarity in handling water supply and sanitation services, with recognition of the benefits of municipal self-regulation and limited interference by the cantons. A corollary is a cultural perception of a duty to pay one's own way, applying equally to households and municipalities. As a result, cost recovery levels are high and metering is widespread. User charges are typically around CHF 2/m^3 for public water supply and CHF 1.5-2.5/m^3 for sanitation. Urban water prices are relatively high by OECD standards (Figure 4.7), amounting to USD 4.36/m^3 in Lausanne, USD 4.52/m^3 in Geneva, USD 4.65/m^3 in Zurich, USD 4.57/m^3 in Basel and USD 6.22/m^3 in Bern, as of December 2013.

Figure 4.7. **Water prices in Swiss cities are fairly high by OECD standards**



Note: Average water supply and sanitation price for households in 2013, based on annual consumption of 200 m^3.
Source: IWA (2014), International Statistics for Water Services.

StatLink http://dx.doi.org/10.1787/888933571758

Switzerland has long propounded a clear set of water charging principles:

- Water should be metered.
- Water prices should cover all costs (Box 4.2).
- Tariffs should comprise a basic fee and a volumetric price, ideally reflecting both the fixed and variable costs of the utility.
- Enough revenue should be earned to maintain the system's assets.

As regards the financing of urban water infrastructure, the cantons are required by law to ensure that capital expenditure and the costs of operating and maintaining sewage collection and treatment facilities are charged to users. The 2007 EPR recommended making further progress in financing the upkeep and renewal of water treatment infrastructure. This

Box 4.2. **WPA provisions for water sanitation funding (Article 60a)**

- The cantons shall ensure that the costs of the construction, operation, maintenance, improvement and replacement of sewage treatment plants are passed on, through user charges, to the parties that produced the sewage. In setting the charges, the following shall be considered:
  a) nature and volume of sewage produced
  b) depreciation, to preserve treatment plants' value
  c) market interest rates
  d) planned investment for maintenance, improvement and replacement to adapt plants to statutory requirements and for operational optimisation.
- If imposing cost-recovery charges that comply with the polluter-pays principle jeopardises the environmentally compatible disposal of sewage, disposal may be financed differently to the extent required.
- The persons responsible for the sewage treatment plants must ensure the required financial reserves.
- The principles for calculating the charges shall be made public.

has been partly achieved. In practice, user charges cover the full costs of operating and maintaining facilities for both sanitation and water supply. User charges also cover all long-term capital expenditure (including renewal) for water supply but, according to the latest survey, only 78% for sanitation. The latest survey on sanitation cost recovery, which for the first time covered investment as well as operation and maintenance costs, was published in 2011 by the Swiss Water Association and the Municipal Infrastructure Organisation, the latter being an agency of the Swiss Union of Cities and the Association of Swiss Communes.[14] It revealed an annual gap in long-term investment coverage of around 22% on a sample size of some 80% of inhabitants connected (VSA and KI, 2011). Average annual expenditure over the last decade on operating costs, interest and investment, excluding depreciation, amounted to CHF 1.7 billion. It was covered by revenue from user charges, connection fees, refunds and financial products. The total including depreciation, however, is CHF 2.2 billion; thus CHF 0.5 billion is not covered by long-term provisions. Timely renewal of sanitation infrastructure will require new sources of long-term investment finance. The WPA requires holders of water facilities to set up reserves covering long-term financing of not only the initial investment, but also its depreciation and renewal. Pursuant to the WPA, Switzerland should ensure that water tariffs cover all sanitation costs, including capital depreciation.

Financing micro-pollutant removal

Micro-pollutants are bioactive and persistent substances in water that can be harmful even in very low concentrations (nanograms or micrograms per litre). For example, feminisation of male fish by hormonally active substances can occur at levels as low as nanograms per litre (Gälli et al., 2009). Micro-pollutants can harm aquatic ecosystems and possibly also human health. Measured micro-pollutant levels in Swiss drinking water do not currently indicate unacceptable risk to the population (ibid). However, over 30 000 potential micro-pollutants are in daily use in industrial, commercial and domestic applications as ingredients in plant protection products, biocides, pharmaceuticals and consumer products

for body care, cleaning and other uses. In 2006, as part of a project to develop a micro-pollutant strategy, FOEN initiated a survey of micro-pollutants in watercourses, based on modelling and measurement campaigns and focusing on substances in urban sewage. Work is continuing on providing a systematic overview on micro-pollutant quantities, uses, releases, behaviour in the environment and toxicity. The number and use of micro-pollutants are likely to rise due to population growth and longer life expectancy (Gälli et al., 2009). While it has initiated micro-pollutant monitoring in water and ecotoxicological evaluation of water pollution, Switzerland has decided to apply the precautionary principle and start reducing micro-pollutant discharges to water bodies without further delay.

Existing legislation on the registration, evaluation, authorisation and restriction of chemicals makes it possible to deal with the most problematic micro-pollutants at source by not placing them on the market. Management of other substances, especially those related to human health such as medications, may prove more sensitive. Hence Switzerland has become one of the first countries to implement a national policy to reduce micro-pollutants in sewage treatment effluent. More than 80% of micro-pollutants can be eliminated with end-of-pipe techniques such as ozone or activated carbon treatment. Consistent with a risk approach, it was decided that such additional treatment should target:

- Switzerland's upstream responsibility for micro-pollutant loads discharged in neighbouring countries' waters, which applies to large sewage treatment plants, i.e. > 80 000 population equivalent (PE)
- protection of drinking water resources, which involves the following plant sizes and locations:
  - > 24 000 PE in lake watersheds
  - > 8 000 PE in karst landscapes
  - > 1 000 PE discharging into rivers feeding selected drinking water wells (implementation at a later stage)
- protection of aquatic ecosystems, which involves:
  - > 8 000 PE discharging into rivers with low dilution capacity
  - > 1 000 PE discharging into sensitive rivers (implementation at a later stage).

A preliminary cost-benefit analysis indicates that about 120 of the country's 800 plants, treating around 50% of Swiss urban sewage, have to be upgraded to meet these criteria (Gälli et al., 2009). The upgrades involve investment of about CHF 1.2 billion (by comparison, the capital cost of the current sanitation infrastructure is about CHF 80 billion[15]). The upgrades are expected to raise operating and investment costs by between 5% and 10% at larger plants and between 15% and 25% at smaller ones. A further estimate gives a range of 7% to 43%[16] depending on plant size and existing infrastructure, with ozone treatment and activated carbon treatment being about equal in cost (Abegglen and Siegrist, 2012).

An estimate of the benefits of upgrading, based on the public's stated preferences (Logar et al., 2014), indicated that the average willingness to pay is CHF 100 per household annually to reduce the potential environmental risk of micro-pollutants to a low level. As the estimated annual cost of upgrading is CHF 86 per household connected, the cost-benefit analysis justifies the investment decision from an economic point of view.

The cantons are responsible for selecting which plants to upgrade, in co-operation with stakeholders and taking watershed management principles into account while aiming to achieve environmental improvement at acceptable cost. Plant operators can

choose which treatment technology to use, as long as it removes at least 80% of trace substances from raw sewage. Indicator substances for enforcement of this standard have been defined. Upgrades must be initiated within 20 years of the entry into force of the WPA amendment (i.e. by 2034).

A fund was created in 2016 to finance the upgrades.[17] It will be maintained until the end of 2040. The WPA provides for the fund to be financed by a federal sewage charge levied until the end of 2040 on plants larger than 200 PE. The level of the charge is based on the number of people connected to the plant, with a ceiling of CHF 9 per resident annually. The Federal Council sets the charge rate, basing it on the expected upgrade costs (currently CHF 60 million a year). The Confederation collects the revenue and allocates it to the cantons. These payments, granted for upgrade works begun between 2012 and the end of 2035, cover 75% of the upgrade costs. Alternatively, the fund may cover 75% of the cost to build connections between smaller and larger, more efficient plants, up to the cost of an upgrade. Plant operators pass on the charge to the users connected. Upgraded plants are charge exempt. Plants that treat exclusively industrial sewage are excluded from the policy; they thus do not need to comply with the upgrade standard or pay the charge. It is too early to assess the effectiveness of the charge. Three plants have already been upgraded and work is under way or planned at several others.

All households and firms connected to a treatment plant larger than 200 PE pay for the upgrade of 15% of them (i.e. 120 out of 800 plants). This enlarged charge base allows sharing the CHF 1.2 billion investment cost more broadly than if only households connected to upgraded plants had to pay. However, the polluter-pays principle would be better applied if the burden were shared at the watershed level, as is the case in England and Wales, where water companies each cover a river basin area. This is clearly the case for medium-sized plants, whose impact is mainly confined to the surface water or groundwater watershed where they are located. It is also the case for large plants, whose effluents flow into specific, mostly transboundary watersheds.[18] The increase in water bills resulting from the charge seems affordable. Relative to other recurring household expenses, such as transport, health insurance and telephone service, the annual sanitation cost is modest in Switzerland.[19] For households connected to sewage treatment it amounts to around CHF 200/year/PE, or CHF 2.30/m^3. However, households connected to very small plants have costs up to 2.3 times higher than those connected to larger plants, mainly due to higher fixed costs for small installations.[20]

The federal sewage charge is aimed at micro-pollutants only. It could be extended to conventional water pollutants, however; some OECD countries levy such pollution charges as incentives to reduce direct discharges to water bodies, including from sewage treatment. Broader pollution charges can represent a significant share of the water bill: about one-third for households in France, for example (OECD, 2010).

Water drainage plans regulate extension of the municipal sewerage network. In particular, the plans entail treating sewage and storm water separately (e.g. by capturing rainwater and preventing runoff) with the aim of improving sewage treatment plant performance. The WPA stated that each municipality had to prepare a plan by the end of 2016; around 90% of municipalities met the deadline. Treatment of storm water helps limit direct discharges of micro-pollutants to water. Work has been under way for some years on more environment-friendly disposal of urban storm water (e.g. polluted pavement runoff). The main objective is to retain storm water and treat it before its discharge into rivers and lakes.

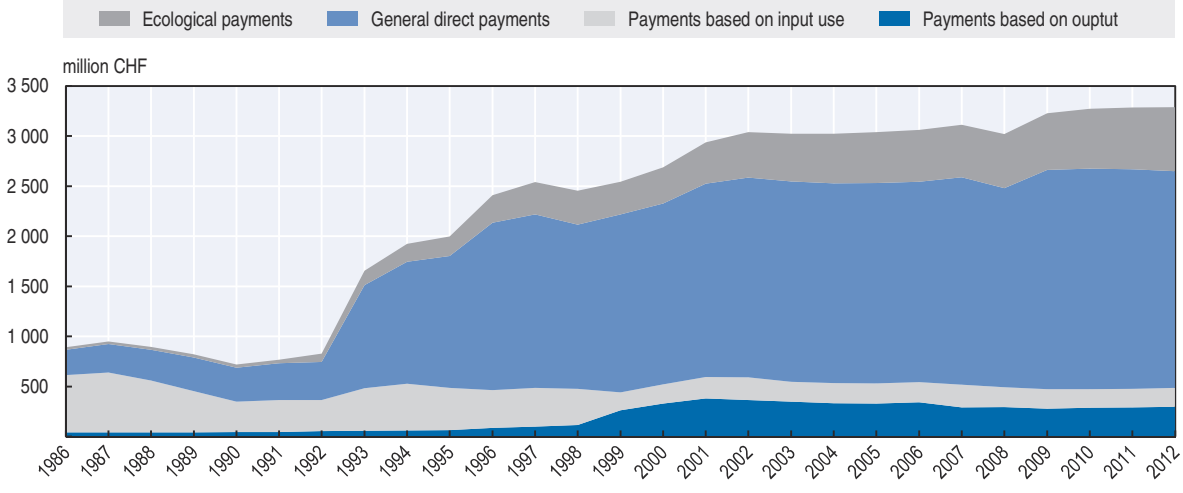
4.2. *Nutrient and pesticide management in agriculture*

Agricultural policy reform

Prior to the mid-1990s, Swiss agricultural policy support was extremely high by OECD standards, at 77% of gross farm receipts in 1986-88. Most of it was potentially production and trade distorting, with measures primarily based on output or input use. The cost of was high for both taxpayers (public financial support) and food consumers (high market prices), and the environmental impact of agriculture was not explicitly addressed. Switzerland has since undertaken significant agricultural policy reforms in response to four agricultural objectives added to the Constitution in the mid-1990s: ensuring food supply, promoting rural development, ensuring that future generations have fertile soil and clean drinking water, and contributing to a varied landscape. As a result, agricultural policy support decreased to 56% of gross farm receipts in 2013-15,[21] though this is still more than triple the OECD average of 17%. In particular, guaranteed prices and markets for agricultural commodities have been gradually removed;[22] some direct payments not tied to specific products (i.e. decoupled from agricultural production) have been introduced, as well as environmental cross-compliance for all direct payments (i.e. all direct payments from the public purse to Swiss farmers have to be based on proof of ecological performance).

There has been no *ex post* cost-effectiveness assessment of the two main categories of direct payments in use between 1993 and 2013: general direct payments and ecological direct payments (Figure 4.8). The former aimed at income support (via area-based payments decoupled from agricultural production); keeping farming in mountainous areas (via payments for farming in difficult conditions); keeping dairy cows (headage payments); and environmental protection (payments for integrated production to enhance biodiversity and soil and water conservation). In 1999, the integrated production payments were discontinued as new environmental cross-compliance requirements were introduced for all general direct payments. The new rules subsumed the integrated production requirements,[23] making some more explicit and stringent, such as limiting nutrient surpluses to 10% at the farm level, prohibiting pesticide use on buffer strips of 6 m along rivers)[24] (compared to 3 m under

Figure 4.8. **Ecological payments to Swiss farmers are growing**



Source: OECD (2014), "Producer and Consumer Support Estimates", OECD Agriculture statistics (database).

Source: OECD (2015), *OECD Review of Agricultural Policies: Switzerland 2015*, *http://dx.doi.org/10.1787/9789264168039-en*.

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the WPA) and requiring at least 7% of agricultural area to be biodiversity promotion areas (e.g. extensive meadows, floral fallows, low-intensity pastures, traditional orchards, tall fruit trees, hedges, hedgerows, wild flower strips, low-intensity cropping strips).

Ecological direct payment programmes, participation in which was voluntary, aimed to reward farmers performing beyond these requirements. Payments were granted for biodiversity promotion areas as well as for summer pasturing (transhumance), extensive cereal farming, organic farming and animal welfare. Participation increased as a larger choice of programmes became available. Since 2000 a separate programme (and payment) has aimed at improving water quality in problem areas (Box 4.3). Some CHF 74 million was allocated to this programme over 2000-15.

Box 4.3. **Payments to protect water quality in agriculture**

Where concentrations of nitrate, phosphorus and phytosanitary products in water exceed the limit values set by the WPO, the cantons must determine the extent and causes of pollution and take the necessary steps for remediation. Article 62a of the WPA, adopted in 1998, provides for federal financial support for cantons implementing such remediation projects. The Confederation's support aims to cover a large part of the cost and the income loss to which farmers are exposed when taking such measures (e.g. to prevent runoff and leaching).[25] The payments are granted if i) the measures are necessary to fulfil surface water and groundwater quality requirements, ii) the canton has delineated the problem areas and co-ordinated the measures required and iii) the measures are not economically viable for farmers. The level of payment is determined by the nature of the substances and the extent of pollution abatement; in addition the payments are not to duplicate support under the Agriculture Act and the Act on the Protection of Nature and Cultural Heritage (NCHA). The Confederation is responsible for monitoring implementation.

Switzerland should assess the cost-effectiveness of this payment system, which should be seen as a transitional measure as it contravenes the polluter-pays principle. It would not do so if eligibility for payments included criteria that went beyond environmental cross-compliance requirements or below WPO limit values.

Due to the low and stagnating nitrogen use efficiency since 1990, a new programme and payment were launched in 2009 to improve input (resource) use in agriculture (Decrausaz, 2010). The programme covers nitrogen, phosphorus and pesticides, as well as more sustainable use of soil, biodiversity and landscape. Some CHF 132 million was allocated to the programme over 2009-15.

Under Agriculture Policy 2014-17, direct payments continue to be subject to environmental cross-compliance rules regardless of whether the objective is food supply, maintaining farming in mountains, or environmental or landscape protection. The main change in the 2014-17 policy is reallocation of payments to more closely align them with specific objectives. General direct payments and ecological direct payments are split into six categories, which allows for more explicit payment objectives (e.g. biodiversity payments, payments for landscape quality) (Box 4.4). However, it is no longer clear which payments reward farmers who voluntarily exceed environmental cross-compliance requirements (as was the case of ecological direct payments until 2013). Another important policy change was replacing headage payments with grassland area payments for dairy cows. The former had encouraged intensification of livestock farming; the latter, though, is conditional upon minimal stocking density.

Box 4.4. **Agriculture Policy 2014-17 payment categories**

1. Food supply payments: rates differentiated between plains and mountains (area-based).
2. Farmland payments: to maintain cultivated landscape in mountains (area-based).
3. Biodiversity payments: for specific outcomes or farming practices (e.g. biodiversity promotion areas).
4. Payments for landscape quality: for crop rotation, flowering fields and traditional agricultural practices (co-financed by the cantons).
5. Payments for production systems: to foster production systems that are environment-friendly (e.g. organic farming) and animal-friendly (area and headage-based).
6. Resource-efficiency payments: for specific farming practices (e.g. manure spreading, no-till farming).

Table 4.4. **A range of direct payments have explicit environmental objectives (CHF million)**

Payment objective	1986-99	2000-15	2000	2007	2013	2014	2015
Extensive meadows	455	1279	91	93	104	0	0
Extensive farming on drylands and meadows whose crops are used as livestock bedding (from 1988)[a]	76	154	11	11	11	0	0
Less intensively used meadows for forage production (from 1993)[a]	112	169	18	13	6	0	0
Extensive meadows (from 1993)[a]	170	847	40	62	80	0	0
Extensive meadows on land under crop rotation and set-aside (1993-2000)	92	18	18	0	0	0	0
Meadows whose crops are used as livestock bedding (from 1999)[a]	5	88	4	7	7	0	0
Extensive area strips (from 1999)[a]	0	3	0	0	0	0	0
Extensive cropland	386	496	33	31	30	32	34
Extensive farming of bread wheat (1992-98)	163	0	0	0	0	0	0
Extensive farming of feed grains (1992-98)	184	0	0	0	0	0	0
Extensive farming of rapeseed (1997-98)	5	0	0	0	0	0	0
Extensive cultivation of grains and rapeseed (from 1999)	35	496	33	31	30	32	34
Natural resource management	0	98	1	5	6	6	17
Measures to protect water quality (from 2000)[b]	0	74	1	5	6	0	0
Contribution to resource use (from 2014)	0	24	0	0	0	6	17
Integrated production of crops (1992-98)	1 646	0	0	0	0	0	0
Organic farming of crops (from 1993)	166	472	12	32	35	40	43
Biodiversity conservation	60	1 485	9	44	110	364	396
Ecological compensation and extensive meadows (1992)	11	0	0	0	0	0	0
Tall fruit trees (from 1993)[a]	220	489	37	35	34	0	0
Green fallow (1993-98)	51	0	0	0	0	0	0
Floral fallow (from 1994)[a]	5	84	4	6	5	0	0
Rotation of fallow land (from 1999)[a]	1	30	3	2	1	0	0
Hedges and rustic groves (from 1999)[a]	3	59	3	3	8	0	0
Contribution to ecological quality (2001-13)[c]	0	551	0	32	95	0	0
Contribution to biodiversity quality (from 2014)	0	367	0	0	0	179	188
Contribution to ecological quality, level 2 (from 2014)	0	223	0	0	0	106	118
Creating networks of highly valuable biodiversity areas (from 2014)	0	171	0	0	0	80	90
Landscape protection	0	477	0	0	0	211	266
Contribution for open landscape	0	281	0	0	0	141	141
Contribution to landscape quality	0	195	0	0	0	70	125
Total amount (CHF million)	2 712	4 307	147	204	285	654	756
% of total direct payments	10	9	6	7	9	20	23

Note: From 2014, some payments have been grouped together under one heading, including:
a) "Contribution to biodiversity quality"
b) "Contribution to resource use"
c) "Contribution to ecological quality, level 2" and "Creating networks of highly valuable biodiversity areas".
Source: OECD (2016), *Agricultural Support Estimates* (database), *http://dx.doi.org/10.1787/83ff9179-en*.

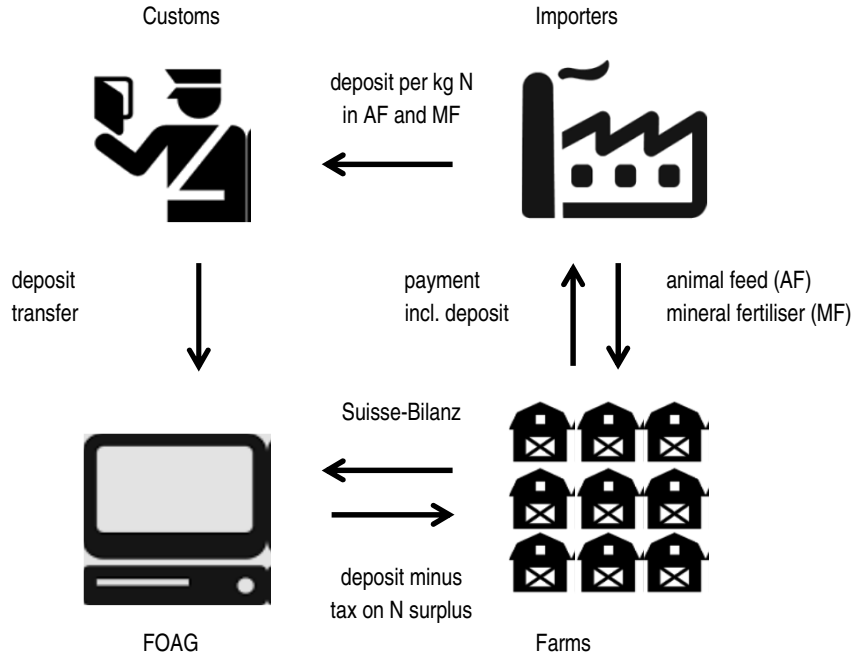
Some direct payments can be qualified as having explicit environmental objectives, such as maintaining extensive meadows and extensive cropland, managing water quality, farming organically, conserving biodiversity and protecting landscape. The proportion of such payments to total direct payments steadily increased from 6% in 2000 to 23% in 2015, with a marked increase since 2014 and implementation of Agriculture Policy 2014-17 (Table 4.4). The payments increasingly focus on preserving biodiversity, extensive meadows and landscape. Such targeting of payments at explicit environmental outcomes is a positive step towards improving agricultural policy cost-effectiveness, as is a shift from public financial support to payments for well-identified ecosystem services. Switzerland has also reduced reliance on payments based on input and output use (Figure 4.8), which tend to incentivise the use of farm inputs. However, a significant share of environment-related payments seeks to reduce reliance on inputs such as nutrients and pesticides, including through organic farming and extensive cropland farming, instead of targeting environmental services. This entails a risk of contravening the polluter-pays principle should farmers be paid to meet their legal requirements. More generally, payments to farmers should be based on local conditions and delivered where needed (i.e. they should take the form of payments for ecosystem services). This is not the case for environmental cross-compliance, which 95% of Swiss farmers practise, and which can be seen more as applying a combination of regulations and public financial support regardless of local environmental conditions.

Nutrient and pesticide management

Agriculture Policy 2014-17 introduced a computer application for simplified farm manure management known as HODUFLU. Pursuant to the WPA, farmers must balance their use of manure with the land available for spreading. If a farmer has too much manure, he can transfer it under certain conditions to another farm that needs nutrients for its crops or, more rarely, to a biogas plant. In the latter case, the residue (digestate) is rich in nutrients and must also be used as fertiliser. HODUFLU, under FOAG, was introduced in 2014 to facilitate and liberalise management of such nutrient flows. Deliveries of farm manure and digestate, previously only possible through written contracts between transferring and receiving farmers, must now be registered with HODUFLU, which contains data from all farmers wishing to transfer or receive nutrients. This allowed simplifying the control of manure flows between the cantons: in 2015, Lucerne and Sankt Gallen cantons transferred the most nutrients, while Berne, Aargau, Zürich and Thurgau cantons received the most. With HODUFLU, nutrient trading was significantly simplified for farmers with nutrient excess, thereby helping them achieve the legal requirement for balanced manure use at the farm level at no cost to the public purse other than operating HODUFLU.

To further enhance cost-effectiveness, HODUFLU could be combined with a tax on surplus nitrogen levied at the farm level, as in Denmark. Schläpfer (2016) proposes this as a cost-effective way to reduce nitrogen pollution in compliance with the polluter-pays principle. The surplus would be calculated from the farm nitrogen balance in Suisse-Bilanz, a farm accounting system for nitrogen and phosphorus. Tax collection would involve a deposit levied on imports of animal feed and mineral fertilisers[26] and refunded after deducting the tax (Figure 4.9). The net revenue would be earmarked for the farm sector. Suisse-Bilanz, introduced in 1999 as part of environmental cross-compliance requirements, must be updated every year. Farms whose livestock density does not exceed their soil holding capacity[27] and which do not import nitrogenous or phosphorous fertilisers, are exempt. Manure exports recorded on HODUFLU are deducted.

Figure 4.9. **How the proposed tax on nitrogen surpluses would work**



Source: Schläpfer (2016), "Eine Stickstoff-Lenkungsabgabe für die Schweizer Landwirtschaft?", *www.agrarforschungschweiz.ch/aktuelles_heft_10de.php?id_artikel=2227*.

StatLink http://dx.doi.org/10.1787/888933573183

In 2014, organic farming accounted for about 133 000 ha, or 9%, of agricultural land, mainly in mountain areas. Some CHF 40 million was paid in 2014 to encourage organic farming. The share of agricultural land under organic farming is triple the estimated OECD average of 3% (Chapter 5).

While Switzerland has begun tackling point-source micro-pollutants from sewage treatment plants, agriculture is a major diffuse source of micro-pollutants in the aquatic environment. In response to the Moser postulate[28] and following a 2014 parliamentary intervention,[29] the Federal Council instructed the Department of Economic Affairs, Education and Research to draw up an action plan for reducing risks and increasing sustainable use of phytosanitary products by the end of 2016, drawing on EU policy.[30] A draft plan, published in July 2016 with 2026 as its time horizon, suggests the adverse effects of phytosanitary products could be halved if their use were restricted, including:

- a 30% reduction in application of agricultural pesticides with a high risk profile and a 25% reduction for other agricultural pesticides
- a 50% reduction in watercourses exceeding water quality requirements (0.1 µg/l)
- reduction by half of the agricultural pesticide risk for aquatic life.

As part of preparation for the phytosanitary product action plan, FOAG commissioned a study to evaluate the feasibility of introducing a pesticide tax to be considered in the development of Agriculture Policy 2022-25. After reviewing pesticide taxes in Sweden, Norway, Denmark and France, the study recommended differentiating taxation by toxicity, as in Denmark (Finger et al., 2016). Due to low price elasticity, high tax rates would be required to significantly reduce demand. Levying the tax at the wholesale level or on industry would reduce transaction costs. Redistribution of the revenue to the farm sector

would raise acceptance and, if well-targeted (e.g. to new technology, alternative farming systems), would provide further incentives to reduce pesticide use. A prerequisite would be to abolish the VAT reduction on pesticides.

4.3. River system rehabilitation

Switzerland has embarked on a long-term endeavour to rehabilitate its rivers to their natural functioning and counteract continued aquatic biodiversity loss. Around 40% of Swiss rivers (50% of those below 600 m) are in poor morphological status and about a quarter have a high degree of fragmentation due to artificial structures that affect the passage of migratory fish, change the natural habitat distribution within rivers and modify their ecological capacity. Other challenges are to conserve the last uninventoried natural watercourses and to revise old, unlimited water use rights that prevent enforcing minimum flow standards.

The policy of river rehabilitation was triggered by a popular initiative, "Living Waters", proposed on 3 July 2006 by the Swiss Fishing Federation (known by its French acronym, FSP) to strengthen the biological functions of watercourses by creating habitats and managing riparian zones. In 2010 the FSP announced the conditional withdrawal of the popular initiative following an indirect counter-project adopted at the end of 2009 by the Federal Assembly to encourage river rehabilitation and reduce the negative effects of hydropower production. The counter-project was not challenged during the five-month prescribed referendum period, resulting in the addition of Article 38a, "Rehabilitation of waters", to the WPA. Paragraph 1 of this article calls on the cantons to ensure that waters are rehabilitated. In doing so, the cantons must take account of the benefits to nature and the landscape as well as the economic consequences of the rehabilitation.

Approval of the counter-project also led to amendment in 2011 of several federal laws relating to river rehabilitation, including the WPA, WMA, Energy Act and Rural Land Act. The amendments define two main orientations:

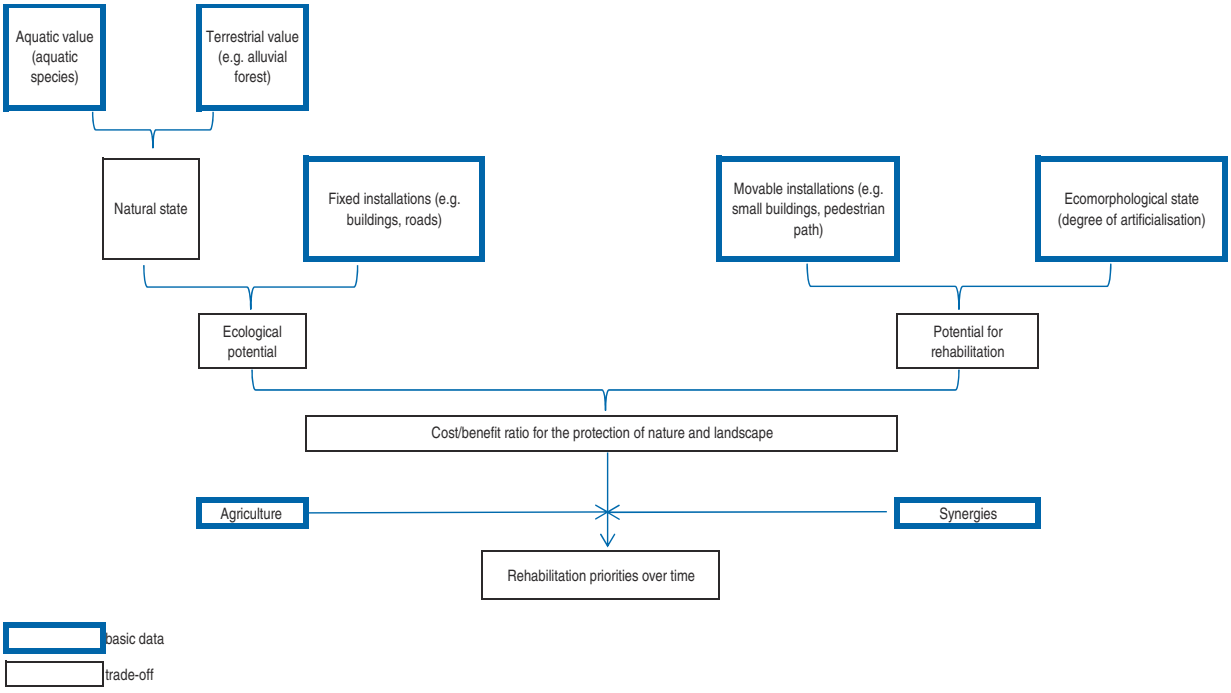
- Encourage river rehabilitation and guarantee a space reserved for water.
- Ensure the ecological improvement of installations related to hydropower use.

A national target was set to rehabilitate about 25% of waters with poor morphological status in the next 80 years, i.e. some 4 000 km of river length by about 2090. This prompted the preparation of cantonal rehabilitation plans, which were due by end 2014. The aim of such strategic planning is to designate priority stretches of river and lakeshore, i.e. to act first where the benefits to nature and landscape are most important in relation to rehabilitation costs. Specifically, the priorities for rehabilitation over the next 80 years are defined in two steps (Figure 4.10).

First, cost-benefit analysis considers the ecological interest of rivers, both aquatic and terrestrial, their ecomorphological state as well as the presence of infrastructures likely to limit the space available to the waters (e.g. roads, buildings). The analysis results from a matrix of the "ecological potential" and the "rehabilitation potential" of stretches of rivers and lakeshore (Table 4.5).

In a second step, the outcome of the cost-benefit analysis is weighed against agricultural constraints and possible synergies in areas such as land improvement, recreation promotion, ecological improvement of installations related to hydropower use, remediation of polluted sites and management of biodiversity hotspots. The resulting priority-setting corresponds to the stretches of river and lakeshore with the most synergies and least constraints. The

Figure 4.10. **Prioritisation of river rehabilitation involves cost-benefit analysis and managing synergies and trade-offs**



Source: Canton of Fribourg (2015), Planification stratégique des revitalisations, rapport final.

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Table 4.5. **Cost/benefit matrix for selecting stretches of river and lakeshore to be rehabilitated**

Benefit to nature against rehabilitation cost	Potential for rehabilitation		
Ecological potential	Low	Average	High
Low	Low	Low	Average
Average	Low	Average	High
High	Average	High	High

Note:
- A "high" benefit-cost ratio means a significant benefit to nature and landscape in relation to the foreseeable costs of rehabilitation.
- A "low" benefit-cost ratio is applied by default to river stretches with a natural ecomorphology (the analysis excludes rivers that already have good ecomorpholgical status).

Source: Göggel (2012), *Revitalisation des cours d'eau : Planification stratégique, un module de l'aide à l'exécution Renaturation des eaux.*

constraints imposed on agriculture are evaluated on the basis of the encroachment of the space reserved for the waters on the utilised agriculture area and the resulting economic loss to the farmer.

However, this approach of rehabilitation where it does not cost farmers and the public purse too much is not conducive to (not sufficiently targeted at) the creation of ecological corridors, i.e. rehabilitation of links between protected areas. In particular, the number of points allocated to river stretches belonging to the National Ecological Network (known by its French acronym, REN) weighs very little on the final score of the assessment of "terrestrial value", which is also the case for points allocated to biodiversity hotspots in the "synergy"

grade (Box 4.5). The REN project aims to improve the connections between existing wildlife habitats, as fragmentation of habitats is a major concern for biodiversity conservation (Berthoud et al., 2004). REN includes the Emerald network of protected areas under the Bern Convention (Chapter 5) and contributes to the establishment of a Pan-European Ecological Network.

Box 4.5. **Criteria to define priorities for river rehabilitation**

Following the example of Fribourg canton, the following criteria are applied in the planning of rivers to be rehabilitated.

Ecological potential

The evaluation of the "aquatic value" of river stretches refers to migratory fish species and threatened fish species:

- fish potential: fish species present or potentially present (historical presence or possible presence with removing artificial obstacles)
- fish habitats: the habitability of the river for adult and juvenile fish
- fish spawning grounds: present or potentially present
- obstacles to fish migration: their number and their height (from 50 cm to > 1 m).

The following criteria are used in the evaluation of the "terrestrial value" of river stretches:

- average slope: the lower the slope of the river, the more terrestrial environments linked to the river
- natural width: the larger the river, the more terrestrial environments linked to the river
- alluvial zones: being part of the federal or cantonal inventory of alluvial zones reflects a higher ecological value of terrestrial environments linked to the river
- being part of the Federal Landscape Inventory reflects the landscape value of terrestrial environments linked to the river; belonging to REN reflects high habitat connectivity.

"Fixed installations" reduce rivers' potential ecological state. They include buildings, roads and railways, large dams, and sewage treatment plant basins.

Potential for rehabilitation

"Ecomorphology" is used to assess the degree of development of river stretches with a minimum length of 25 m: Class III, IV and V rivers are considered highly developed. Rivers above 1 200 m are excluded because they often have natural characteristics (i.e. human impact is generally very low) and can dry up in the course of the year. The following criteria are used in the evaluation of the ecomorphology of river stretches:

- natural/semi-natural (class I)
- little affected (class II)
- very affected (class III)
- non-natural/artificial (class IV)
- buried in tunnels (class V).

The greater the number of "movable installations" in the river stretch, the more difficult and costly the rehabilitation. Movable installations include storage sites and operating areas such as small buildings (less than 30 m^2), pedestrian paths, polluted sites and buried gas pipes. A distinction is made according to the risk they represent for rivers' ecological state:

- category 1 (low stress): risk is considered negligible due to the materials and/or location of the storage site or operating area

Box 4.5. **Criteria to define priorities for river rehabilitation** *(cont.)*

- category 2 (medium stress): the installation is a source of risk but not to the point of triggering an investigation
- category 3 (significant constraint): the installation is classified as needing investigation given the high risk to rivers' ecological state.

Agriculture

Agricultural constraints mean restrictions on agricultural use of the space reserved for water, which is required by law and is therefore independent of future rehabilitation. The WPA amendments specify that the space reserved for water must be used in the form of a biodiversity promotion area.

Synergies

"Land improvement" in rural areas creates opportunity to give more space to rivers, which will facilitate their rehabilitation.

"Recreation" includes measures to make rivers accessible and attractive to the population. This includes huts, picnic spots or education trails in riverside forests; riverside forests with a social function; hiking trails; aquatic activities (canyoning, kayaking), camping areas (within 100 m of the river); schools (within 100 m of the river); as well as rivers located within a tourist area or a regional natural park. These recreational functions all have the same weight in the final "recreation" grade, which does not really contribute to improving the connectivity between regional natural parks.

Remediation of "polluted sites" can create synergy with rehabilitation efforts.

Planning is co-ordinated between the "ecological improvement of installations related to hydropower use" (which mainly concerns large rivers) and river rehabilitation; river stretches affected by hydropeaking are evaluated in terms of their synergy with the rehabilitation and the restoration of the natural processes of sediment transport is taken into account through the rehabilitation. Another goal of rehabilitation is to remove obstacles to free fish migration. Considering that the ecological improvement of installations related to hydropower use falls under other cantonal planning, only the obstacles not related to the hydropower sector and of a height of more of 50 cm are considered.

Synergies with "biodiversity hotspots" are sought. This includes river stretches with high species diversity ("species" stretches) or containing priority species at the national level ("EPN" stretches). However, biodiversity hotspots have little weight in the final "synergy" grade, which does not help much to improve connectivity between them.

Source: Canton of Fribourg (2015).

The Swiss Biodiversity Strategy (Objective 2), calls for Switzerland to establish functional "ecological infrastructure" of protected areas and connection areas to conserve biodiversity (Chapter 5) (Federal Council, 2012). It is not only a question of filling gaps in the protected area system, but the connection areas must also be completed and permanent throughout the territory. All sectors, but first and foremost the river system, must have a part in the ecological infrastructure concept. The recent Swiss Biodiversity Strategy action plan should contribute to meeting this objective.

Arnold et al. (2009) estimated willingness to pay for various features of river rehabilitation, such as the natural state of rivers (slightly closer or close to nature) and access (river-bank paths and their length). Rivers that are close to nature were considered important as

aesthetically attractive elements of the landscape. The ability to pursue recreational activities such as hiking, walking and cycling along the banks of watercourses that are close to nature was found to be equally important. Willingness to pay for river rehabilitation ranged from CH 50 and 150 CHF per person per year in the cantons covered by the study (Jura, Solothurn, Vaud and Zurich).

Space for waters

According to Article 36a of the WPA, introduced in 2011, the cantons must delimit sufficient space to allow the rivers to fulfil their natural functions and to guarantee protection against floods and the use of water. The cantons must delimit this "space for waters" by the end of 2018 and include it in their master plan and land use plan.

Rivers with sufficient space fulfil many important functions. They connect ecosystems and provide the water needed for life. Rivers serve an essential function as habitats for animal and plant communities, provide recreational areas for humans and play an important role in the self-purification of waters and in feeding the water table. When rivers flood, however, they can threaten residential areas and farmland. For all these reasons, it is important to reserve sufficient space along watercourses. Excessive use of watercourse space has increased risk to settlements in flood-prone areas, to biodiversity from downstream river development projects and to water quality where river edges are intensively farmed; it has also increased flood risks where stream channelling leads to faster river flows and higher peak flows. Hence the importance of co-ordinating measures relating to flood protection, water protection, agriculture, nature and landscape protection, and recreation planning.

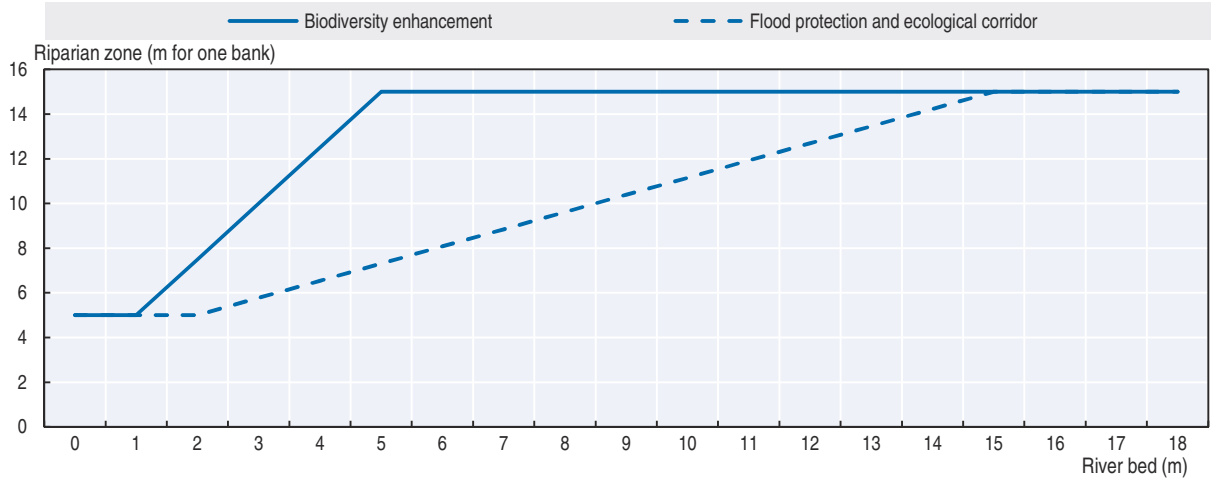
Protecting against floods and providing space for waters go hand in hand. The WMA requires flood protection to be linked to ecological solutions and watercourse rehabilitation. If these objectives are to be attained, it is first necessary to provide sufficient space for watercourses. Spatial planning instruments are particularly relevant to ensure space for waters. The Watercourse Management Ordinance (Article 21) requires the cantons to consider space for waters in their master plans and land use plans. Cantonal and municipal land use plans allow for enforcement of this space or imposition of protective requirements by regulating landowners' land use rights. Some cantons, such as Zurich, can reserve space for waters by imposing construction limits. For landowners for whom land use restrictions cannot reasonably be imposed, the authorities can opt for purchasing land to ensure the required space. The new Ordinance on Structural Improvements, which is part of agricultural legislation, enables authorities to co-finance land purchase in the context of land consolidation or other land improvement.

The 2007 EPR recommended preparing flood management plans and including flood risk in cantonal and municipal land use plans. This has partially been achieved. There are no flood management plans at river basin level but flood protection is an integral part of land use planning (Section 4.4). In addition, in 2016 FOEN published a flood protection implementation aid for use by the cantons, municipalities and the private sector. Based on lessons from case studies, the aid provides guidance at each stage of risk management, from risk assessment to implementation of flood protection measures, with the aim of achieving an "acceptable" level of flood risk.

To determine the necessary space for waters, a simple method is used, applicable to small and medium-sized watercourses, which account for between 70% and 80% of the hydrographic network. The river bed's natural width is the reference value from which the

width of the riparian zone is obtained by means of a nomogram (Figure 4.11). In less exploited areas, a much wider space – the river meander bend – can be delimited to maintain the watercourse's natural dynamics. A recreational space will be considered within these limits or beyond if the watercourse and its banks are to be used for recreational activities.

Figure 4.11. **A nomogram is used to determine the necessary space for surface waters**



Source: SAEFL/FOWG (2003), *Guiding Principles for Swiss Watercourses: Promoting Sustainable Watercourse Management, www.sib.admin.ch/fileadmin/_migrated/content_uploads/DIV-2703-E.pdf.*

StatLink http://dx.doi.org/10.1787/888933573221

The river bed is defined as watercourse width at average water level. In its natural state, the channel in which a river flows has a diversified structure and offers habitats for aquatic plants, fish, birds and other life forms. It is also the part of the waterway that fulfils the function of transport. In the case of artificialised watercourses, the natural width of the river bed is estimated from reference sections that have remained in the natural state.

The riparian zone, which includes the river banks, serves as a habitat for a multitude of animal and plant species. Depending on river bed width, a riparian zone capable of performing its functions can extend between 5 m and 15 m on either side. Above 15 m it is considered an autonomous riparian biotope. In Figure 4.11, the values on the continuous line represent the minimum recommended space to ensure habitat networking and flood protection. To enhance biodiversity, more space is necessary, represented by the values on the dashed line. The Ordinance on Substances prohibits use of pesticides and fertilisers on a 3 m strip to either side of the river bed; this buffer strip is part of the riparian zone. In agricultural areas with high nutrient inputs due to steep slope, intensive farming or lack of riparian vegetation, the buffer strip must be extended to or even beyond the limits of the riparian zone.

The river meander bend allows for natural formation of meanders. It should reach at least five to six times the width of the river bed and is delimited only if a project is meant to maintain or restore a watercourse's natural dynamics.

Streams are attractive as recreational areas, especially when they are easily accessible. A recreational space of at least 3 m (e.g. for roads) should be provided on sections close to residential areas or along traditional walking or cycling routes.

Minimum flow

Since 1991 there have been three levels of minimum flow requirements for new water use rights. The ten-year average of the flow reached or exceeded 347 days per year (Q_{347} flow rate) is used to determine the first level (WPA Article 31, para. 1). For small rivers (with a Q_{347} flow rate up to 60 litres/second) this level is relatively higher than for larger rivers. For small rivers, water use is possible only if a minimum flow of 50 l/s is maintained. The reason is that the ecological balance is very fragile for this type of river, which is of particular importance as living space for young fish and the aquatic life they feed on.

The minimum flow requirements must be increased to a second level (WPA Article 31, para. 2) if the WPA requirements are not satisfied in terms of i) water quality (e.g. low dilution of sewage), ii) groundwater supply, iii) protection of biotopes whose existence is directly related to the nature and size of the watercourse and iv) free migration of fish. The minimum flow must also increase in the case of rivers crossing inventoried landscapes and biotopes or in case of "overriding public interest" (e.g. landscape criteria such as presence of a waterfall).

These two levels do not take into account the ecological differences of the various rivers (i.e. the same requirements apply for all rivers). This is why the WPA provides for a third level of minimum flow requirements (WPA Article 33), which consists of setting "acceptable" minimum flows after a weighing of economic and environmental interests, including landscape protection, biotope protection, long-term water quality, and long-term groundwater protection. The third level must be at least as high as the second level (preferably higher). Round tables allow the weighing of interests between enhanced environmental protection (more stringent minimum flows) and economic development (e.g. using water for hydropower). There are successful examples of round tables that led to setting minimum flows in accordance with legal requirements (WPA, Article 33) while taking existing water use rights for hydropower into account (Box 4.6).

Box 4.6. **Example of weighing of interests**

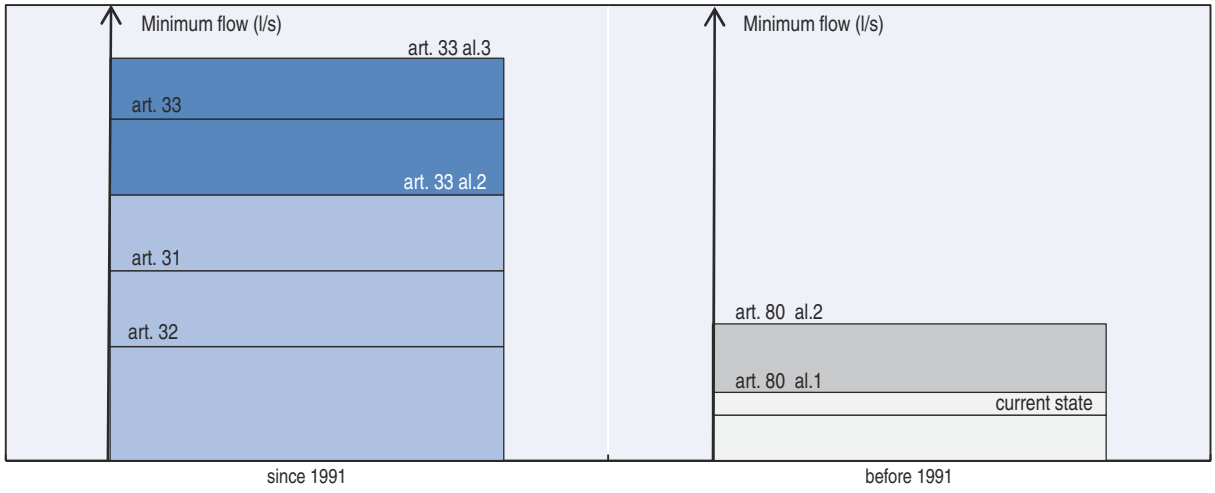
In Grisons canton, a round table gathered together a hydropower plant operator and other stakeholders (FOEN, SFOE, the canton, environmental NGOs) plus independent experts. Prior to the round table, the authorities developed the environmental bases and the hydropower company the energy and financial bases. The round table lasted two days, during which the actors observed first-hand the rivers concerned and discussed options to increase minimum flows, then found a compromise based on knowledge of the ecological, energy and financial impact. All stakeholders signed the minutes of the round table at the end of the two days. The authorities' decision following this round table was not appealed and the new minimum flows are being applied.

Even where much less stringent minimum flow requirements apply by derogation (under Article 32) weighing of interests is required. Derogations apply to the use of hydropower in rivers with no surface water flow for at least 18 days per year, on average (i.e. 5% of the year). This is often the case for many small rivers in the Alps above 1 700 m, where surface water freezes much of the winter. Since 2011 the derogation has also applied to rivers of low ecological potential.

Articles 31-33 of the WPA do not apply to water use rights granted before 1991, where the much less stringent Article 80 applies (Figure 4.12).[31] Article 80 (1) specifies that minimum

flow requirements only apply if they do not infringe upon existing user rights to such an extent as to justify compensation. Under Article 80 (2), stricter minimum flows apply to watercourses crossing landscapes or biotopes listed in a national or cantonal inventory, or where overriding public interest requires, even if they infringe upon existing user rights to the point of justifying compensation. By end 2016 about 25% of hydropower plants built prior to 1991 did not meet the 2012 deadline for complying with Article 80 requirements (FOEN, 2017b). One of the few examples of Article 80 (2) being implemented is on the River Doubs, where authorities compensated a hydropower plant operator for income loss so as to increase residual water use for nature conservation.

Figure 4.12. **The minimum flow differs depending on whether the rights of use were granted before or after 1991**



Notes : The minimum flow levels are given for illustrative purposes, in practice they vary according to the local conditions. Article 31: no weighing of interests. Article 32: derogations. Article 33: weighing of interests. Article 33 alinea 2: economic interests that must be taken into account. Article 33 alinea 3: ecological interests which preclude the taking of water. Article 80 alinea 1: ecological improvement not infringing existing user rights. Article 80 alinea 2: additional ecological improvement required.
Source: Michel et al. (1997), *Prélèvements d'eau : Rapport d'assainissement, Assainissement selon art. 80 al. 1 de la loi sur la protection des eaux, L'environnement pratique.*

StatLink http://dx.doi.org/10.1787/888933573240

Some very old rights of water use for hydropower are unlimited in time, which prevents enforcement of the minimum flow standards set in 1991. This is the case for most smaller hydropower installations (around 1 000, out of a total of 1 150), for which minimum flow is not regulated other than by Fishing Act provisions. An environmental NGO, Pro Natura, recently reviewed the legal basis for hydropower use in the various cantons (Vetterli, unpublished).

Hydropower development

Since 2011 all installations related to hydropower use have had to meet three types of requirements to ensure their ecological improvement, in addition to the Articles 31-33 minimum flow requirements. These new requirements relate to hydropeaking (affecting 100 installations), changes in sediment transport (affecting 500 installations) and obstacles to fish migration (affecting 1 000 installations). Hydropower accounts for about 60% of Swiss electricity production and is spread over the Rhine, Rhône, Po and Danube watersheds. When preparing Energy Strategy 2050, which postulates the abandonment of nuclear energy in the medium term, the SFOE estimated that there was still potential for hydropower development. In a 2012 study, the SFOE found that Switzerland would have the capacity to

increase its hydroelectric production by 9%, from 35.4 TWh in 2010 to 38.6 TWh in 2050, without contravening current water protection regulations. Some 70% of the increase would come from new installations large and small, with the rest from expansion of existing large plants. Some NGOs argue that the implied increase of 3.2 TWh/year can hardly be achieved without breaching minimum flow requirements, strict application of which to existing plants would reduce current production by 1.4 TWh/year.

An extension of the federal alluvial zone inventory currently under preparation may significantly reduce the scope of hydropower development by 2050 – possibly halving it for large plants, an unpublished SFOE estimate indicates.[32] A new Energy Act (not yet in force, it was unsuccessfully challenged in a May 2017 referendum) provides for weighing of interests regarding areas that are part of the Federal Inventory of Landscapes, Sites and Natural Monuments of National Importance, which includes some alluvial zones. However, the new law precludes such weighing of interests for renewables development in non-inventoried alluvial zones and other non-inventoried protection zones, such as dry grasslands. Thus it would be possible to build new hydropower plants in protected landscapes and biotopes, except those inventoried as being of national importance. With few exceptions, all new hydropower development will intersect with protection of nature and landscape. As alluvial zones naturally are concentrated around watercourses[33] there is an obvious need to manage trade-offs between their protection and hydropower development. The surface area of alluvial zones may seem negligible in terms of biodiversity conservation – the 282 zones cover 226 km^2, 0.55% of the national land area – but comparing them to the area coverage of Swiss rivers (342 km^2, excluding lakes) makes their significance clear. The weighing of interests between hydropower development and alluvial forest protection should be the rule rather than the exception, as it would allow the setting of residual flow levels that are acceptable to all stakeholders.

Financing river rehabilitation

The 2007 EPR recommended establishing funding mechanisms for watercourse rehabilitation. This has been achieved. Since 2011 public financial support has been granted for rehabilitation works (via environmental policy) and for provision of space for waters (via agricultural policy), while electricity consumers (via a tax on electricity bills) support ecological improvement of installations related to hydropower use (Table 4.6). These instruments are combined with direct regulations on minimum flows and come in addition to the public financial support for flood control that was in place before 2011.

Table 4.6. **Financing mechanisms have been established for watercourse rehabilitation**

Policy aim	Financing		Rationale
	Confederation	Cantons and/or municipalities	
Rehabilitation projects	2/3 (CHF 40 million/year)	1/3 (CHF 20 million/year)	The Confederation is mostly responsible for biodiversity protection
Space for waters	1/1 (CHF 20 million/year)		Farmers are rewarded for managing riparian land as biodiversity promotion areas
Flood control	1/3	2/3	Flood control particularly benefits the cantons
Ecological improvement of installations related to hydropower use	100% via a tax on the electricity bill (up to CHF 50 million/year)		Compensation by virtue of the rights acquired following the granting of a concession for hydropower use

Source: FOEN (personal communication).

The Confederation and cantons share responsibility for financing river rehabilitation projects. Federal and cantonal funding may cover up to 80% of rehabilitation work: a fixed 35% and additional funding depending on i) the cost/benefit ratio for the protection of nature and landscape of the selected stretch of river or lakeshore (additional 10%-20%), ii) the extent of space reserved for waters (additional 25%-40%) and, for a limited number of projects, iii) the relevance for local recreation (additional 10%). The cost-benefit analysis is based on the stretch's ecomorphological status, its natural state and existing installations, such as buildings and roads, on riparian zones (Figure 4.10).

Since 2016, public financial support for rehabilitation projects has been granted only to cantons that have prepared a river rehabilitation strategic plan. This federal allocation to the cantons is based on the cantonal river network length and its morphological status, as well as on negotiation.[34] In practice, the Confederation and the cantons jointly prepare programme agreements within the framework of the 2008 fiscal equalisation reform and related division of tasks between the Confederation and the cantons (Chapter 2). These programme agreements set out the rehabilitation objectives and the amount of federal subsidies available.

The space for waters can be farmed, but only as biodiversity promotion areas, in which case the farmland may benefit from public financial support under WPA Article 62b (Box 4.7). CHF 20 million a year has been budgeted under the agricultural policy for the purpose. In addition, landowners and authorities may agree contractual solutions on a case-by-case basis. The cantons and municipalities have considerable room for manoeuvre in this area. For example, Berne canton has enacted special regulations to grant additional payments to farmers.

Box 4.7. **Payments for farmers to provide space for waters**

Article 62b of the WPA provides for federal financial support for the cantons implementing space for water measures. The level of support is determined by the relevance of the measures to the re-establishment of waters' natural functions as well as by the effectiveness of the measures. Farmers providing space for waters are eligible for direct (compensatory) payments, in accordance with the 1998 Agriculture Act, for promoting biodiversity on their lands.

This is justified insofar as farmers are getting paid for going beyond what agricultural policy requires them to do anyway as, under cross-compliance, biodiversity promotion areas should be set aside on at least 7% of the farm.

The rehabilitation of a given stretch of river or lakeshore may be financed under different legal provisions. In particular, there may be rehabilitation projects under the WPA and flood protection projects under the WMA. The two types of projects are essentially subject to the same ecological requirements, as the acts contain identical articles,[35] given that most flood protection projects also benefit nature and the landscape. In practice, however, flood protection projects take precedence over rehabilitation projects where flood risks are high.

Another combination of legal provisions exists with rehabilitation measures to be taken in high-value alluvial biotopes, such as alluvial forests, marshes and amphibian breeding sites. In principle, rehabilitation measures are financed under the WPA while maintenance

of recovered biotopes along watercourses is covered by the NCHA. Indeed, the NHCA provides that the Confederation may allocate subsidies to the cantons for protection measures in selected landscapes and biotopes (Chapter 5). Thus the rehabilitation policy under the WPA may significantly contribute to achieving the biodiversity policy objectives to protect biotopes of national importance under the NHCA, and vice versa. Moreover, alluvial forest management (like forest management in general) is eligible for public financial support under Swiss forestry policy.

A further combination of legal provisions exists with financial contributions under the Agriculture Act (Article 14 of the Ordinance on Structural Improvements) for rehabilitation of small rivers in agricultural areas. Such rehabilitation can be considered a land improvement measure and be financed as accompanying measures in the context of agricultural structural adjustment policy. Alternatively, if the rehabilitation is not realised as part of land improvement, it can be financed under WPA Article 62b provided it promotes biodiversity protection.

A wide variety of public financial support has thus arisen to pay landowners for the multiple facets of river rehabilitation in terms of protection of nature and landscape, providing space for waters, flood protection and agricultural land improvement. Switzerland ought to ensure synergies and coherence between the different rehabilitation objectives assigned to the same stretch of river or lakeshore. This means evaluating the additionality of ecosystem services (e.g. flood as well as nature and landscape protection; land improvement as well as biodiversity promotion). Where there is an overlap of policy objectives for a given stretch of river or lakeshore, no double funding should be allowed for one and the same service provided, pursuant to the 1990 Federal Act on Financial Aid and Compensation (Subsidies Act, Article 12).

Since 2011 hydropower plant operators have had to limit the negative impact of hydropeaking (WPA Article 39a), changes in sediment transport (WPA Article 43a) and obstacles to fish migration (Fishing Act Article 10). Installations built since 2011 have to comply with these new standards. All installation built before 2011, whatever their size, are eligible for financial support to facilitate their upgrading (i.e. ecological improvement) by 2030. Ecological improvement is entirely financed via a tax of 0.1 cent/kWh on electricity bills,[36] in accordance with the Energy Act (Article 15abis). The tax rate is set to raise up to CHF 50 million a year (CHF 1 billion over 20 years). This support ("compensation") does follow a kind of "electricity pays for electricity" principle but seems to contravene the polluter-pays principle, which would require plants' operators to cover the ecological improvement cost. However, the provision takes into account operators' acquired rights, which ensure full compensation for any limitation of hydropower use that entails excessive costs.

Financial support for ecological improvement of hydropower installations comes on top of other financial incentives for hydropower development as part of energy policy. Since 2013, as part of the first phase of Energy Strategy 2050, financial support has been able to cover part of the investment in new plants, the aim being to increase hydropower's share in the renewables mix. This incentive is financed via additional levies on electricity bills: 0.1 cent/kWh for large plants, 0.03 cent/kWh for small ones.[37] Since 2013 and until 2018, a market premium of 0.2 cent/kWh is granted to existing large plants. Electricity consumers also subsidise hydropower development via market price support. Since 2008, new and upgraded plants[38] of less than 10 MW capacity have been eligible for feed-in-tariffs (FITs). The smaller the plant, the higher the FIT rate;[39] the rates are lower for installations on

natural watercourses (as opposed to those on watercourse stretches already in use) as an incentive to protect natural watercourses from too much hydropower development. FITs were granted for 25 years for installations built before end 2013, and for 20 years since then. FIT policy is under review (Chapter 3).

On the other hand, hydropower plant operators are subject to a tax for the use of water to produce electricity (the tax is combined with water use rights). The tax rationale is the use of a public resource. Revenue from taxation of hydropower production totals around CHF 550 million a year nationwide and accrues to the cantons where the hydropower is produced. The tax is designed so that the more hydropower is generated, the higher the tax amount, which creates incentives for cantons to develop hydropower. This is particularly the case in the Alpine cantons, where the proceeds make up a significant share of cantonal budgets. The amount of the tax is obtained by multiplying the theoretical installed capacity (kW_B) by a tax rate (CHF/kW_B) the maximum of which is set by law. Hydropower plants above 1 MW[40] of installed capacity are subject to the tax, whose rate can also vary by type of plant.[41] A higher rate for plants requiring dams is environmentally justified because dams entail risk of hydropeaking, changes in sediment transport, obstacles to fish migration and eutrophication. In some cantons, the tax is based on power generated and water withdrawn. For example, in Jura canton the rate decreases when large diversion facilities take more than three-quarters of the average annual river flow and when large impoundment facilities make higher withdrawals in summer than in winter. Such regressive taxation (the tax rate decreases as withdrawals increase) is a disincentive to comply with minimum flow rules.

The maximum tax rate was set at CHF 110/kW_B for 2015-19 (compared to CHF 8/kW_B when the tax was first introduced in 1916). Since the mid-1970s the maximum rate has been increased significantly to ensure higher revenue for the mountain cantons and, until 2008, to follow significant increases in electricity prices. Since 2008, however, market prices on European electricity exchanges have collapsed. For example, prices negotiated in Leipzig fell by around 66% between 2008 and 2016 (after adjusting the exchange rate effects for Switzerland). The tax now accounts for about one-quarter of the operating cost of hydropower plants and half the market price for electricity, which is significant. The water and electricity sectors have called for a revision of the rate after 2019 to take these changes in electricity prices into account (ASAE, AES and Swisselectric, 2017). The tax should reflect pressures on water resources, for example by acting as a sanction for non-compliance with standards on ecological improvement and minimum flow. To this end, its design should change from an objective of revenue raising to that of an incentive-based instrument.

4.4. *Drinking water supply and groundwater protection*

Groundwater supplies some 80% of drinking water. There are increasing conflicts between land use intensification and groundwater abstraction, sometimes requiring the closure of existing drinking water abstraction stations or preventing the creation of new ones. The WPA says the cantons must take the necessary groundwater protective measures by subdividing their territory into groundwater protection areas (GPA) and groundwater protection zones (GPZ). The purpose of the GPA designation is to protect exploitable groundwater, while the GPZ designation is intended to protect existing drinking water abstraction areas.

The cantons have been responsible for delimiting GPAs in their territory since 1992. GPAs must be included on cantonal water protection maps. The maps serve as guidelines for authorities and have no direct effect on landowners.[42] The GPAs aim to protect

groundwater for future use; no one may construct or carry out development within them that is deemed likely to compromise future exploitation of the groundwater.

The cantons must then delimit GPZs to protect existing groundwater abstraction areas. GPZs are subdivided into three concentric zones: zone S1 ("abstraction area"), zone S2 ("close protection") and zone S3 ("remote protection"). Their delimitation is the most important land use planning measure for groundwater. About 60% of GPZs have been designated so far, with a further 30% provisionally designated. Industrial activity involving a threat to groundwater is prohibited in S3 zones. In S2 zones, construction is also forbidden, whatever its type. A general prohibition on land use applies in S1 zones. Farming is permitted within S2 and S3 zones but application of slurry is prohibited in S2 zones, and only pesticides that are sufficiently biodegradable and not very mobile can be used. Specific areas ("areas of contribution") must be delimited when groundwater is polluted by substances such as nitrates[43] and pesticides, or at risk of such pollution. In these areas, the Confederation may compensate farmers for up to 80% of remediation costs under WPA Article 62a (Box 4.3).

There are no legal requirements to include GPAs and GPZs in cantonal master plans and land use plans. The only legal requirement is for cantons to publish general maps of GPAs, which are still a work in progress. Yet GPAs and GPZs are key instruments of groundwater protection, and as such should be an integral part of land use planning. In this respect, Switzerland needs to extend to the protection of groundwater what is already being done regarding flood protection and space for waters. Since 1998, flood protection has had to be an integral part of land use planning. Red, yellow and blue flood risk areas must be delineated, and land cannot be allocated for development in red (high) flood risk areas.[44] Nor can landowners rebuild in red areas and there is no compensation for the loss of structures such as houses. Since 2011, space for waters has to be included in land use plans, using the methodology shown in Figure 4.11. Both flood risk and space for waters must be included in the cantonal land use plan; after seven years, when that plan is renewed, they must also be included in the municipal land use plan. Similar practices have long been in place for avalanche risk.

Direct abstraction of water is subject to taxation. Municipalities propose a tax rate to the cantons, often following consultation with professional associations. In some cantons (e.g. Jura), the tax may be increased when the canton incurs special expenses for protection or exploitation of GPZs; in the case of Jura canton the increase has been as much as quintuple the usual rate. The objective is to charge users (cities, industry, farmers) all, or a fair share, of the expenses. This is consistent with the beneficiary-pays principle, whereby authorities should require those who benefit from groundwater protection to contribute to its cost. The tax is, in a way, the price to pay for the lack of groundwater protection in the past and the failure to take into account the protection of groundwater in today's cantonal land use planning. However, the abstraction tax rate varies according to use,[45] which is difficult to justify from an environmental point of view, which holds that the rate should be the same regardless of how the water is used. In other words, preferential rates for certain user categories should be avoided. Also, the rate is significantly lower on abstraction from in surface waters rather than groundwater (e.g. one-quarter of the rate on groundwater in Bern canton), as groundwater is assumed to be more vulnerable to depletion. Rather, the tax rate should reflect the actual or estimated drought risk for a given body of water, whether it be an aquifer, a river or a lake. Unlike direct regulations on land use, in the area of economic incentives Switzerland should not extend flood protection practices to groundwater protection. Flood insurance premiums are the same in all cantons (in line with the solidarity

principle) whatever the actual risk. Another lever of action in terms of taxation would be to review the design of fiscal autonomy for municipalities, which creates strong fiscal incentives to allocate land for new residential development on the outskirts of municipalities in an attempt to attract high-income taxpayers (Chapter 5).

Recommendations on water management

Urban sewage treatment and micro-pollutant removal

- Pursue efforts to upgrade urban sewage treatment plants with a view to reducing risks of water pollution by micro-pollutants; consider extending micro-pollutant abatement and control policy to industrial sewage.

Nutrient and pesticide management in agriculture

- Speed up release of the action plan for reduction of risks and sustainable use of phytosanitary products; in that context, consider phasing out the VAT concession on pesticides and phasing in pesticide taxation at production and wholesale points, based on toxicity.
- Consider introducing a tax on nitrogen surpluses at the farm level as a sanction for non-compliance with legal requirements under the WPA.

River system rehabilitation

- Consider the whole range of water-dependent ecosystems when selecting stretches of river and lakeshore for rehabilitation; in particular, foster the role of well-functioning river systems as connection areas within the ecological infrastructure concept called for by the Swiss Biodiversity Strategy.
- Consider revising long-standing rights of water use for power that impede rehabilitation of small rivers and designating selected river stretches as being of national importance, thereby triggering the weighing of interests between hydropower development and ecosystem rehabilitation for these river stretches.
- Ensure synergies and coherence between the different river rehabilitation objectives (e.g. in terms of hydrology, flood protection, protection of nature and landscape, farmland improvement); in particular, evaluate the additionality of ecosystem services and the overlap of policy objectives related to the rehabilitation of the Swiss river system.
- Extend water quality monitoring to small rivers and small lakes and improve understanding of their ecological functioning to develop protection measures, given their ecological importance and their high exposure to agricultural pollution.

Drinking water supply and groundwater protection

- Consider making the delimitation of groundwater protection areas and groundwater protection zones legally binding and having them fall within the framework of cantonal and municipal land use plans.

Notes

1. Hydropeaking refers to artificial, abrupt and frequent variations of river flow linked to hydropower dam exploitation.
2. Aggradation is deposition of river sediment on land.
3. Water services are often part of an "umbrella" municipal utility delivering electricity and gas as well as water services. The Swiss Gas and Water Industry Association is the federation of such utilities.

4. From Lake Geneva to Lake Constance, the population density is 411 people/km^2, comparable to that of the Netherlands.
5. "Open" land is cultivated land excluding artificial grassland.
6. Electricity generation by impoundment (accumulation or storage dams) represents about half of Swiss hydropower production. The other half is generated by diversion from "run-of-river" plants erected on the plain, on rivers with significant flows. Unlike storage dams, run-of-river structures still offer some untapped hydropower potential in Switzerland.
7. A postulate is a request that a member of parliament conveys to the executive. The postulate titled "Micro-pollutants in Water: Strengthening of Measures at Source" was tabled on 7 March 2012 by Councilor of States Claude Hêche.
8. At 60 kg/ha of agricultural land, on average, in 2011-13, Switzerland has the eleventh largest nitrogen surplus among OECD countries.
9. "Natural Living Conditions and Resource-efficiency in Agricultural Production: Updating the Objectives", tabled on 13 December 2013 by National Councilor Kathrin Bertschy.
10. Introduced in 1993 as ecological compensation areas; the terminology changed in 2014.
11. Outside the alpine regions, socio-economic changes – notably economic and urban growth – have more influence on water management than climate change.
12. It is estimated that 30% of the volume of Swiss glaciers have already been lost in the past 30 years. Recent research reveals that melting of alpine glaciers in Europe is occurring at a much more sustained pace than previous studies had suggested: 65% more than was believed over 2003-12 (Vincent et al., 2017).
13. "Water and Agriculture: The Challenges of Tomorrow", tabled on 17 June 2010 by National Councilor Hansjörg Walter.
14. The survey takes place every six years. It does not cover industry.
15. CHF 66 billion for public sewerage (mostly municipal owned and operated) and CHF 14 billion for central sewage treatment plants (owned and operated by intermunicipal co-operatives). Capital cost of private sewerage, house connections and very small decentralised sewage treatment, for which landowners and homeowners are responsible, accounts for an additional CHF 40 billion.
16. This would add between CHF 0.05 and CHF 0.30 per cubic metre to the average sewage treatment cost of around CHF 0.70/m^3.
17. On 21 March 2016, the parliament amended the WPA to create the fund and define its financing arrangements, retroactive to 1 January 2016.
18. Switzerland is part of the watersheds of five European rivers: the Rhine and Rhône, which originate in Switzerland in the Gotthard massif, and the Danube, Po and Adige, tributaries of which originate in Switzerland.
19. The Federal Statistical Office reports annual expenditures of Swiss households include, on average, CHF 1 440 for fixed and mobile telephone, CHF 3 408 for compulsory health insurance and CHF 5 172 for transport.
20. The annual sanitation cost averages CHF 395/PE for the smallest sewage treatment plants (100 to 1 000 PE) and CHF 172/PE for the larger ones (over 50 000 PE).
21. It rose, however, from 49% in 2013 to 62% in 2015.
22. For example, the milk quota system was abolished in 2009, at the same time as guaranteed prices for dairy farmers.
23. Integrated production included requirements on manure application, crop rotation, pesticide management and animal welfare; in addition, at least 5% of farmland had to be cultivated as extensive meadow or floral fallow. A supplementary payment was granted if integrated production applied to the whole farm.
24. Except for wine and fruit growing.
25. Remaining costs to farmers can be shared by various parties (cantons, municipalities, water utilities, sponsors).
26. Swiss agriculture imports around 100 000 tonnes of nitrogen annually in the form of mineral fertilisers and feedstuffs (Schläpfer, 2016).

27. That is, on which the quantity of nutrients applied per hectare is less than 2 to 0.8 livestock units, depending on whether the farm is in the plains or the mountains.
28. "Action Plan to Reduce Risks and Promote the Sustainable Use of Phytosanitary Products", tabled on 16 March 2012 by National Councilor Tiana Angelina Moser.
29. Inquiry by National Councilor Silva Semadeni: "How many pesticides can our watercourses bear?"
30. EU Directive 2009/128/EC established a framework for action to achieve sustainable use of pesticides, with member states required to draw up action plans by end 2012.
31. Concessions for hydropower use are granted for 80 years, pursuant to the Act on Hydropower Use. Articles 31-33 of the 2011 WPA apply to concessions renewals or granting of new concessions.
32. It is based on a list of large hydropower plant projects as of 2012.
33. Alluvial zones are not restricted to rivers but also cover land areas.
34. The federal allocation to the cantons is equally shared between programme conventions and bigger single projects. Bern and Grisons cantons receive the highest federal allocations over 2016-19.
35. WPA Article 37 (2) and WMA Article 4 (2
36. The tax is levied per kWh transported on the high-voltage network.
37. The 0.03 cent/kWh tax is also used to finance investment in biomass energy.
38. Upgraded plants in which electricity production has increased by at least 20%.
39. The 200 largest hydropower plants account for about 90% of Swiss production and the 400 largest for 98%. Many of the remaining 750 are below the limit of profitability.
40. A megawatt is equal to 1 341 horsepower.
41. For example, in Jura canton the annual tax for hydropower use is CHF 12/HP for small installations, CHF 16/HP for large diversion facilities and CHF 20/HP for large impoundment facilities.
42. It is still possible to challenge A_u sector boundaries when filing a building permit application.
43. In this they resemble the nitrate vulnerable zones under the EU Nitrates Directive (91/676/CEE).
44. Floods are expected to become more frequent in Switzerland. As urbanised areas expand, flood risk protection is rapidly gaining in importance.
45. For example, in Bern canton the annual water abstraction tax is CHF 10/litre/minute for industry, CHF 7/l/min for drinking water supply, CHF 3/l/min for cooling water and CHF 20/ha irrigated for irrigation water.

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PART II

Chapter 5

Biodiversity conservation and sustainable use

This chapter reviews the pressures on Switzerland's biodiversity and its status and trends, as well as institutional, governance and financing arrangements to promote conservation and sustainable use. It also assesses Switzerland's progress in using regulatory and economic instruments for biodiversity conservation and sustainable use, and efforts to mainstream biodiversity considerations into sectoral and other policies.

1. Introduction

Switzerland is at an important point in the evolution of its biodiversity conservation and sustainable use policies. While improvement has been made in some areas (such as water quality and forest cover), biodiversity's overall state is poor and pressures persist. The adoption of the Swiss Biodiversity Strategy in 2012 held the promise of reversing downward trends and restoration of ecosystems and habitats. The accompanying action plan was only recently launched and it is not clear whether there will be sufficient financial resources to implement the actions. Efforts to mainstream biodiversity considerations into sectoral and other policies, and the knowledge basis to underpin integration, have improved but have been inadequate to address key pressures such as pesticide use, ammonia emissions, landscape fragmentation and habitat disturbance. There are opportunities to improve the situation, however, through greater use of economic instruments, better information and awareness, a renewed effort on protected areas and pursuit of creative measures such as wildlife corridors and refuges to limit and mitigate the adverse impacts of development.

2. Status, trends and pressures on biodiversity

Switzerland, located in the heart of Europe, has a varied geography and climate that have produced a wealth of biodiversity (EDA, 2016) and ecosystems (Box 5.1). Much of the country is mountainous, with the Alps to the south and south-east covering 60% of the total surface area and the Jura to the north-west covering 10%. These mountains surround the central Swiss Plateau, which takes up the remaining 30% (EDA, 2016).

Biodiversity was significantly affected by intensive land use change in the 19th century, with the development of urban and agricultural areas (predominantly on the plateau). Deforestation, watercourse alteration and wetland destruction harmed ecosystems and species. The country is restoring and reconnecting degraded ecosystems and trying to prevent further species loss, but progress is challenged by agricultural intensification and urban sprawl on the plateau, land abandonment and climate change in the mountains, and invasive species (Federal Council, 2015; CBD, 2016a). The latest report by the Federal Office for the Environment (FOEN) finds that biodiversity is in an unacceptable state, with the quality and area of valuable habitats in decline and threats to endangered species growing (FOEN, 2017a).

Biodiversity loss threatens crucial ecosystem services that people need, such as clean air and water, soil fertility, climate regulation and pollination of crops and wild plants. Biodiversity helps protect against natural hazards, benefits human health and well-being, absorbs CO_2 emissions and provides with food, fabric fibres and construction materials. Well-functioning ecosystems help filter and store precipitation for drinking water and regulate pathogens and invasive species. Mires and wetlands absorb excess precipitation and forest ecosystems protect against rockfalls, avalanches, landslides and floods. The resiliency of ecosystems against extreme events is depends on the presence of a variety of animals, plants, fungi and microorganisms (Federal Council, 2015).

Box 5.1. **Ecosystems of Switzerland**

Agro-ecosystems: With almost 11% of the country consisting of arable land and cropland and 30% covered in pastures and meadows, agro-ecosystems are an important factor in biodiversity. Agricultural land use decreased by around 1% between 2005 and 2014, with cropland at lower altitudes being converted to settlements, transport infrastructure, and commercial and industrial buildings, and higher-altitude pastures being abandoned.

Forest ecosystems: In the 19th century, many forests were harvested for timber and their area reached a low of about 0.7 million ha in 1840 (WSL, 2017). They have since recovered to 1.28 million ha as a result of policy changes and now represent 31% of the surface area. Forest cover was enhanced by near-natural management introduced in the 1876 Forest Inspectorate Act and 1991 Forest Act. However, the area of old forests, forests with high deadwood levels or young well-lit forests is insufficient to support biodiversity. While natural regrowth on abandoned pasture continues to take place in the Alps, forests at lower altitudes face pressures from urban sprawl and infrastructure development.

Inland water and wetland ecosystems: Large-scale alteration of surface waters' structure and channelling or straightening of watercourses to allow for land use or flood protection has significantly affected water and wetland ecosystems. Between 1900 and 2010, the surface area of biodiversity-rich mires (wetlands such as bogs and fens) decreased by 82% and that of alluvial zones adjacent to watercourses by 36%. Water ecosystems have also deteriorated due to development and pollution.

Grasslands: In the mountains, pasture abandonment is resulting in forest regrowth but also grassland loss. While expansion of forest cover can be positive for some species, grasslands are important ecosystems for butterflies, pollinators, birds and plants. Butterflies in Europe have declined by almost 50% since 1990.

Alpine and subalpine areas: Alpine areas have a high level of biodiversity. For example, 600 species of plants and flowers live exclusively in alpine areas. Around half the alpine area was wooded originally, but was transformed into mountain pasture, creating new ecosystems. The state of alpine and subalpine ecosystems is generally better than at lower altitudes, but faces pressure from tourism, sport and recreation. Climate change is also a significant threat, with lower-altitude species colonising higher altitudes and alpine habitats shrinking.

Source: FOEN (2017), *State of biodiversity in Switzerland: Results of the biodiversity monitoring system in 2016*; FOEN (2014a), FOEN (2014a), *Switzerland's Fifth National Report under the Convention on Biological Diversity*, *www.cbd.int/doc/world/ch/ch-nr-05-en.pdf*; Fischer et al. (2015), *État de la biodiversité en Suisse en 2014*, *https://sciencesnaturelles.ch/uuid/b126284d-fe5b-566d-859f-427b241c5366*; EEA (2013), *The European Grassland Butterfly Indicator: 1990-2011*, *www.eea.europa.eu/publications/the-european-grassland-butterfly-indicator-19902011/at_download/file*.

2.1. Biodiversity data collection, monitoring and dissemination, and scientific expertise

Switzerland has a strong biodiversity monitoring and research system relying on public, academic and independent organisations. In the 1990s, the country initiated groundbreaking work in conservation biology through the Integrated Biodiversity Project of the Swiss National Science Foundation, which was triggered by ratification of the Convention on Biological Diversity (CBD). This led to the 1999 founding of the Swiss Biodiversity Forum, a platform of the Swiss Academy of Sciences that contributes to basic scientific knowledge, processes data and disseminates them among target groups, and promotes national and international collaboration and networking. The forum and FOEN constitute the local branch

of the Intergovernmental Platform on Biodiversity and Ecosystem Services, established in 2012 (SCNAT, 2016a).

With regard to monitoring, FOEN is obliged by the Ordinance on the Protection of Nature and Cultural Heritage (1991, amended 2015) to monitor long-term development of biodiversity nationwide. Switzerland has monitored biodiversity since 2001 through the Swiss Biodiversity Monitoring (BDM) programme (BDM, 2016; FOEN, 2014a), which is based on the OECD pressure-state-response model (OECD, 2003). It tracks and reports on 32 indicators, many of which are relevant to tracking progress towards the Aichi targets. In 2011, FOEN and the Swiss Federal Institute for Forest, Snow and Landscape Research jointly launched Monitoring the Effectiveness of Habitat Conservation in Switzerland, a programme focused on biotopes of national importance that tracks and analyses habitat state through flora and fauna surveys and aerial images.

FOEN maintains red lists of threatened species, in addition to species diversity data managed by publicly funded external organisations (FOEN, 2014b). Federal inventories of mires, landscapes and natural monuments of national importance have been developed, and the inventory on alluvial zones is being extended (Federal Council, 2015). The national data and information centre on Swiss flora maintains a black list of invasive plant species with adverse effects on biodiversity, public health or the economy, and a watch list of species that could cause damage (FOEN, 2010). Since biodiversity policy responsibilities and accountability, as well as biodiversity databases, are spread across several institutions and governance levels, the Swiss Information System Biodiversity (SIB) was set up as a single-window tool as part of Switzerland's contribution to the global network of clearing-house mechanisms under the CBD.

Other monitoring programmes relevant to biodiversity include the Agricultural Species and Habitats' Monitoring Programme, the National Forest Inventory, a river monitoring and survey programme, a programme monitoring spatial development, national landscape monitoring, air pollution monitoring, soil monitoring and the national climate observation system (FOEN, 2014b). In addition, non-government organisations (NGOs) contribute through initiatives such as the Swiss Species Recovery Programme for Birds, launched in 2003 by SVS/BirdLife Switzerland, the Swiss Ornithological Institute at Sempach, and FOEN, and research projects on carnivore ecology by a group known as KORA.

While overall Switzerland is deemed to have robust biodiversity monitoring, there is no publicly available map showing ecosystem distribution at the national level, and biodiversity information at the cantonal, regional and local level is not always geo-referenced. Moreover, many data sets are categorised differently (e.g. by region or using differing ecosystem categories), making it difficult to develop a complete national picture. Cantons are, however, working towards implementing federally defined standards. Connecting data from biodiversity monitoring with real-time information on land use or pressures (e.g. regarding agricultural inputs or management practices) could greatly benefit analysis. A national ecosystem map could also serve as the basis for a formal, legally binding spatial planning tool (Section 4.2).

Despite hosting the secretariat of The Economics of Ecosystems and Biodiversity, an initiative of the United Nations Environment Programme, Switzerland has not progressed significantly on estimating the economic benefits of ecosystem services, though it has developed biophysical indicators for some services and an ecosystem service planning tool to assist in assessments, including environmental impact assessments (ÖSL, 2016). The

Swiss Biodiversity Strategy includes a commitment to quantitatively record ecosystem services by 2020 as complementary indicators to GDP and for use in regulatory impact assessments (FOEN, 2012a). This work, combined with the development of a comprehensive nationwide map of ecosystems and habitats of importance, will help lay the groundwork for development of monetary values for ecosystem services that will support consideration of biodiversity alongside economic and social factors in decision making. For example, an analysis showing that Switzerland saves USD 64 million a year by using untreated groundwater, naturally filtered through forested watersheds, makes a strong business case for protecting that ecosystem service (IUCN, 2011).

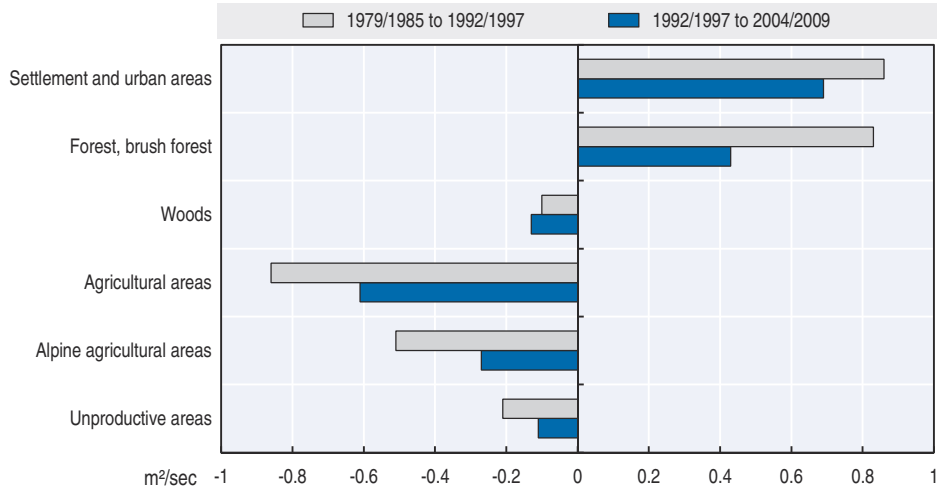
2.2. Ecosystems

Over the last decade, ecosystems such as wetlands and grasslands have experienced increasing pressures due to land use change and landscape fragmentation, as well as deteriorating quality from pollution. Settlement and urban areas have expanded, while dry meadows and pastures have been lost. An estimated 47% of ecosystems are threatened, though forest area has increased. Water-dependent and wetland ecosystems are particularly vulnerable, with reduced surface area and quality.

Land use change

Land use has changed over the past two decades (Figure 5.1). Between 1985 and 2009, 54 516 ha of agricultural area was transformed into settlement and urban areas. Between 1992-97 and 2004-09, agricultural area declined by 2.2%. Some two-thirds of the loss was due to the spread of settlement and urban areas, with the remaining third due to reforestation on hill and mountain areas no longer used for grazing (Federal Council, 2015). Abandoned pastures in the mountains have been returning to forest, which can have a positive impact for some species and a negative impact on those dependent on grasslands. Biodiversity-rich dry meadows and pastures lost around 95% of their area between 1900 and 2010, resulting in a loss of breeding birds and specialised plants (FOEN, 2017a).

Figure 5.1. **Urban areas and forests expanded while agricultural areas shrank**



Source: Federal Council (2015), Environment Switzerland 2015, based on Federal Statistical Office land use statistics.

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Expansion of urban areas can diminish ecosystem quality, reduce wildlife habitat size, increase landscape fragmentation, hasten the spread of invasive species, disturb nocturnal species with artificial light and increase conflict with protected area objectives (EEA and FOEN, 2016). For a small country such as Switzerland with a growing population, urban sprawl is a significant issue for biodiversity conservation and sustainable use. Switzerland has one of the highest population densities in the OECD, particularly on the Swiss Plateau.

The rate of increase in land use for infrastructure has exceeded those of population and GDP growth over the past two decades, indicating that land use expansion has not been decoupled from economic and population growth. Settlement and urban area per capita has remained relatively stable in urban agglomerations but increased significantly in rural areas with a smaller population spread across a larger area. For example, urban sprawl in Basel, Geneva and Zurich declined between 2002 and 2010, but increased considerably in 93% of municipalities (Federal Council, 2015).

Landscape fragmentation

Landscape fragmentation in terrestrial ecosystems remains a significant issue for biodiversity. Over the past 70 years, the landscape has increasingly been fragmented by expanding development and infrastructure. Barriers in the landscape restrict species movement and reduce habitat size. Vertebrates and insects also face risks from traffic on roads. Fragmentation has a greater impact on species requiring substantial space, such as European lynx, red deer, and frogs and toads (BDM, 2010). A 2012 inventory of 304 wildlife corridors (habitat areas connecting wildlife populations separated by human activities or structures) revealed that only 80 were intact. Over 57% of them had reduced functionality, and over 16% could no longer be used by large animals (FOEN, 2016a). Fragmentation and decreased connectivity may also decrease ecosystem resilience and species' ability to move and adapt to climate change.

One measure of fragmentation is effective mesh size, i.e. the size of patches remaining free of barriers that cut up landscape, such as roads and railway tracks. Figure 5.2 shows the reduction in effective mesh size by region between 1935 and 2007. Increasing connectivity of landscapes will be an important component of biodiversity conservation and sustainable use efforts, particularly in the Swiss Plateau and Jura, which have very low mesh size due to major population centres as well as agriculture, industry and tourism. Mountain regions are also becoming more fragmented, increasing the importance of maintaining and improving connectivity.

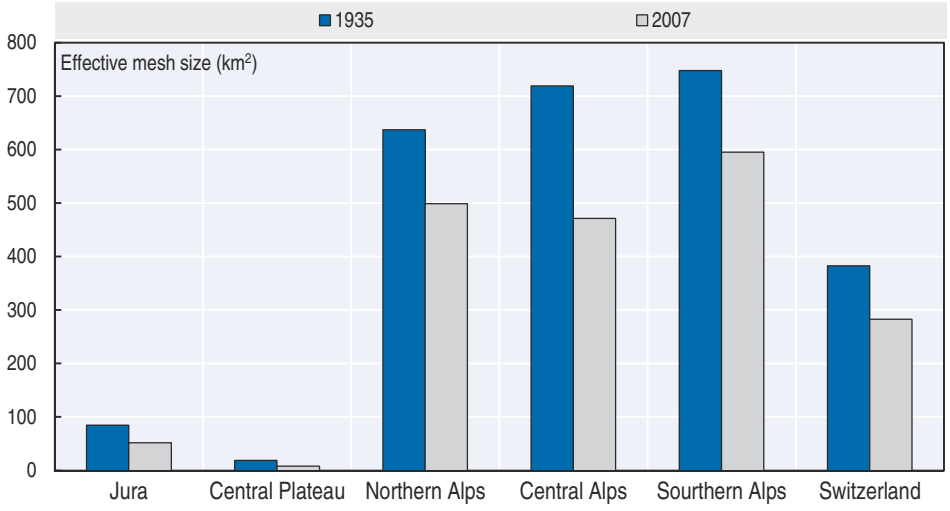
Threatened ecosystems

A 2014 assessment by academics of 162 ecosystems in Switzerland found that close to half were threatened (Table 5.1). In the European Union, about three-quarters of habitats covered by the Birds and Habitats Directives are in an unfavourable state (EC, 2015). Switzerland faces similar challenges to EU countries, with wetlands and grasslands among the most threatened ecosystems. Still waters (lakes and ponds) are also significantly threatened in Switzerland. Pressures stem from both a loss of territory and deterioration in quality (Fischer et al., 2015).

Impact of air pollution on ecosystems

There is ample evidence of nitrogen deposition's impact on biodiversity, particularly in meadows and wetlands, where it leads to eutrophication and the disappearance of

Figure 5.2. **Landscape fragmentation is highest in the Jura and Swiss Plateau, but mountain regions are also increasingly fragmented**



Source: BDM (2010), Landscape Fragmentation.

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Table 5.1. **Still waters, shores and wetland ecosystems are particularly threatened**

Ecosystem (# of ecosystems evaluated)	Percentage threatened of areas assessed %
Still waters (8)	100
Running water (18)	50
Shores and wetlands (20)	85
Glaciers, rocks, moraines and rockfalls (14)	29
Meadows and pastures (30)	43
Forest edges (treeline), tall grasses, scrub (25)	12
Forests (29)	41
Pioneer vegetation and weeds (18)	61
Total (162)	47

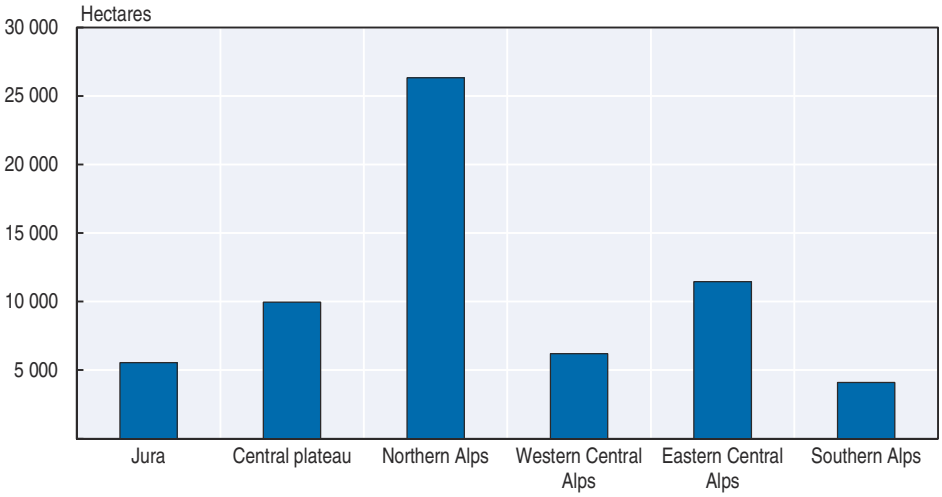
Source: Fischer et al. (2015), *État de la biodiversité en Suisse en 2014*, *https://sciencesnaturelles.ch/uuid/b126284d-fe5b-566d-859f-427b241c5366*.

oligotrophic species. Two-thirds of the nitrogen originates as ammonia from agriculture and the rest as nitrogen oxides (NO_X) from fossil fuel combustion. This is also an international issue, under the Convention on Long-range Transboundary Air Pollution.

Habitats of national importance

Habitats of national importance (HNIs) were established in Switzerland in the early 1990s with raised bogs and alluvial zones and later expanded to include fens and amphibian spawning areas, and finally dry meadows and pastures in about 2010. The areas were selected because they were particularly beautiful, were typical of certain kinds of habitat and provided shelter for unique animal and plant communities (BDM, 2016). HNIs cover 23% of Switzerland, but only 4% of the country is strictly protected in terms of conservation enshrined in law (FSO, 2016). The Northern Alps have the largest area of HNIs, followed by the Eastern Alps and Swiss Plateau (Figure 5.3).

Figure 5.3. **Few habitats of national importance are strictly protected, and they are mostly in mountainous regions**



Source: BDM (2016), Biodiversity Indicators.

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HNIs are often endangered. They were significantly affected in the last century, and continue to face pressures from urban sprawl, infrastructure, agriculture and other activities. This is particularly the case for water-dependent and wetland ecosystems.

Water-dependent and wetland ecosystems

Only around 60% of Switzerland's watercourses (50% of those below 600 m) are in an ecomorphologically natural or near-natural state (Chapter 4). Some 25% of watercourses are fragmented by artificial barriers that affect their physical processes and ecological functions (Chapter 4). Unsurprisingly, the proportion of adversely affected watercourses is higher in the more densely populated Swiss Plateau and Jura. In 2011, Switzerland put in place a policy to rehabilitate some watercourses (Chapter 4). To avoid overflows and flooding, lake water levels have also become more regulated over the past two decades, causing lower than-normal-natural seasonal water level fluctuations and the shrinking of marshes and alluvial zones (FOEN, 2017).

Between 1997 and 2006, the surface area of raised bogs shrank by 10% and of peat-forming fens by 6%, while non-peat-forming fens grew by 9% (BDM, 2016). Over the period, mires (bogs and fens) became drier and more nutrient-rich, lost peat content and saw an increased share of woody plants. These trends indicate that HNIs have not been effective in protecting wetlands.

Ecosystem quality has also deteriorated due to micro-pollutants in water. In particular, around 4 800 km of waterways contain micro-pollutants that come mainly from sewage treatment plants (Chapter 4). These substances (e.g. from plant protection, medicinal and cosmetic products) can affect the nervous and immune systems of aquatic organisms as well as fish reproduction (FOEN, 2014b).

2.3. Species

Switzerland is known to be home to 46 000 species, and experts estimate that another roughly 20 000 species exist in the country. Only 49 species are endemic (not found

elsewhere); 97 species and 19 subspecies have over 50% of their global range restricted to Switzerland (FOEN, 2017a, 2014a). Between 1900 and 1990, significant declines in species occurred (Box 5.2). Since then, the rate of decline has slowed but many rare species are at risk of extinction due to their small population size (FOEN, 2014b).

Box 5.2. **Bat populations have declined due to pesticides and habitat fragmentation**

About 60% of bats are considered threatened in Switzerland. Studies exploring the reasons have found pesticides to be the most significant culprit, particularly dichlorodiphenyltrichloroethane (DDT) for timber treatment in attics. Some populations have recovered since substances including DDT were banned in the 1970s. Habitat fragmentation and loss present an obstacle to recolonisation of former ranges, however, given bat feeding patterns.

The lesser horseshoe bat (*Rhinolophus Hipposideros*), for example, has seen its population severely decline over the past 50 years. The species was once common and widespread, but has faced regional extinction in northern and western Switzerland. Lesser horseshoe bats are particularly sensitive to disturbance in their nurseries, winter roosts and foraging habitats.

Source: BDM (2016), *Biodiversity Indicators*, *www.biodiversitymonitoring.ch/en/home.html*; Universitat Bern (2016), *Conservation Biology: Lesser Horseshoe Bat, www.iee.unibe.ch/abt_cb/content/research/lesser_horseshoe_bat/index_eng.html*; Bontadina et al. (2001), *The Lesser Horseshoe Bat Rhinolophus hipposideros in Switzerland: Present Status and Research Recommendations, www.researchgate.net/publication/228083819_The_lesser_horseshoe_bat_Rhinolophus_hipposideros_in_Switzerland_Present_status_and_research_recommendations.*

As of 2012, one-quarter of known species had been evaluated in terms of the categories defined by the International Union for Conservation of Nature (IUCN). Of these, 36% were categorised as threatened: 3% regionally extinct, 5% critically endangered, 11% endangered and 17% vulnerable (FOEN, 2014b). As in most OECD countries, reptiles and amphibians are particularly under threat (Figure 5.4). Switzerland has some of the highest percentages of threatened species across OECD countries, particularly for mammals and amphibians (Figure 5.5). Over the past ten years, the overall situation for endangered species has not significantly improved, though in recent years small numbers of previously extinct mammals have begun to return, including bears, wolves, golden jackals, lynxes and foxes, as a result of forest cover expansion and increases in prey such as deer (FOEN, 2017a).

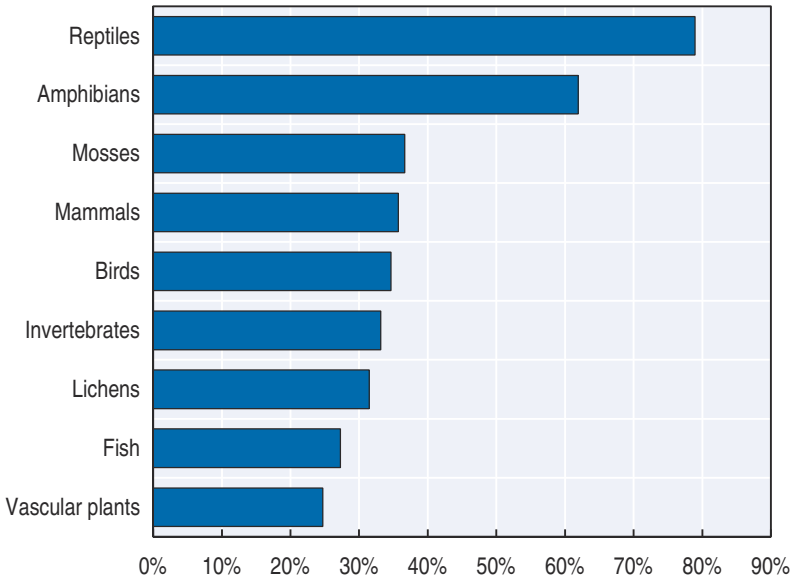
Many of the lost species were specialised, dependent on particular habitat types. In recent decades, the most significant causes of species endangerment have been farming, removal of habitats such as trees, changes to groundwater and alteration of surface water bodies (FOEN, 2014b).

Species diversity

Recent biodiversity monitoring shows that while the number of species in sampled areas is increasing or staying the same across Switzerland, vascular plant communities are becoming increasingly similar in most of the country (Table 5.2). In the Jura, breeding bird species are also becoming more uniform (BDM, 2016). The homogenisation of habitats and species communities is attributed to land use change and high nitrogen inputs that contribute to ecosystem eutrophication (Section 4.1) (FOEN, 2017a).

Figure 5.4. **More than one in three species is threatened**

Threatened species as % of known species, late 2000s



Note : Threatened species = IUCN categories critically endangered, endangered and vulnerable.
Source: OECD (2016a), "Threatened species", *OECD Environment Statistics* (database).

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Invasive species

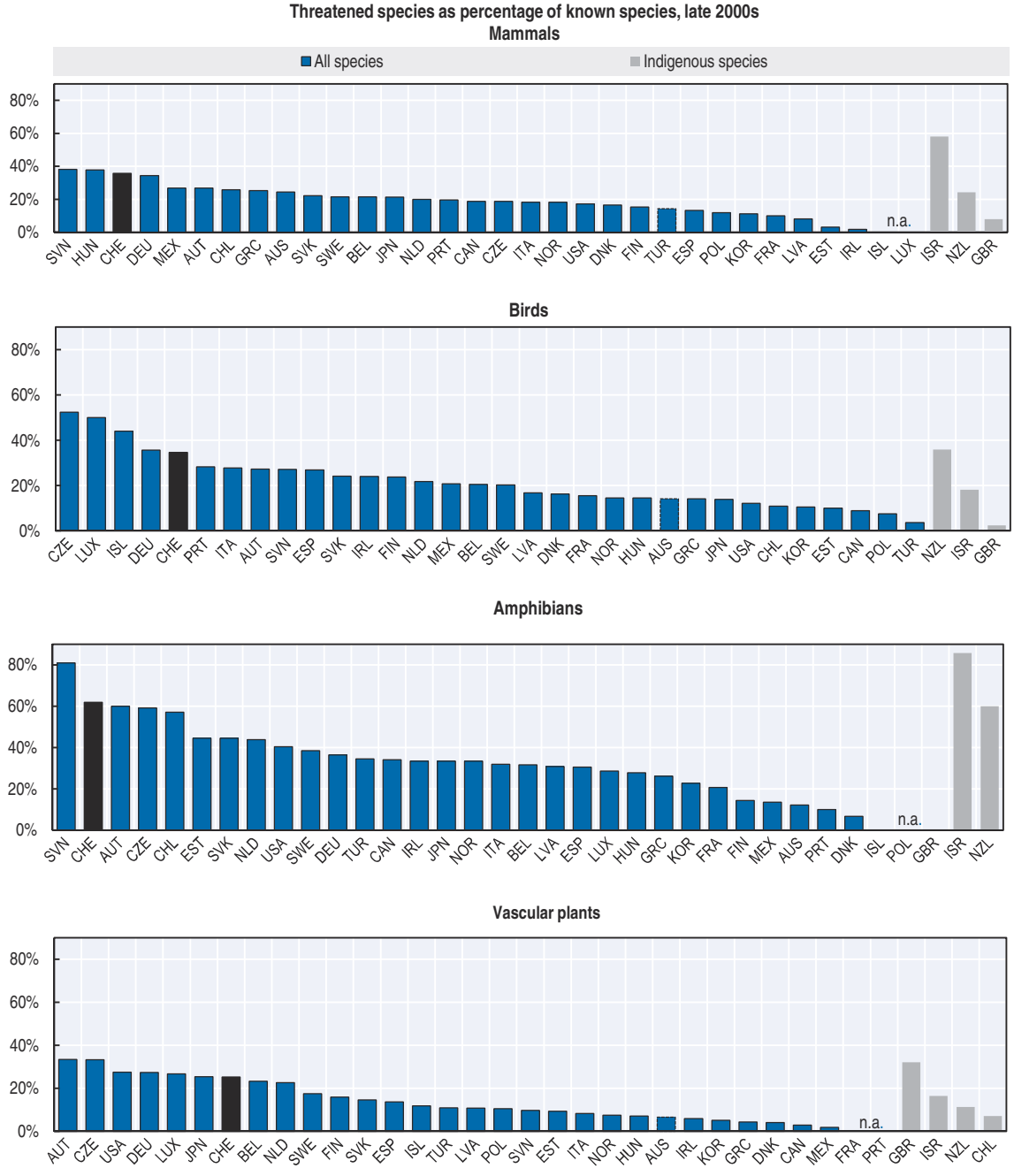
Ecosystems that are degraded due to other pressures are often vulnerable to invasion and establishment of alien species. Around 800 alien species have been documented in Switzerland, with 107 assessed as invasive: five mammals, four birds, one reptile, three amphibians, seven fish, four molluscs, sixteen insects, six crustaceans, three spiders, two worms, seven fungi, one bacterium and forty-eight plants (FOEN, 2014b). Invasive species can replace native species, cause illness and transfer parasites to local species. The emergence of invasive species in valuable habitats such as alluvial zones and amphibian spawning sites has posed particularly problems (FOEN, 2017a). The Asian lady beetle (*Harmonia axyridis*), for example, was introduced to Europe to control aphid species in agriculture. While it is effective at controlling aphids, it also displaces native coccinellids, is a pest in fruit production and can infest homes (GISD, 2016).

Impact of climate change on species

Warming temperatures are resulting in plants developing earlier in the spring and previously low-altitude species being seen in Alpine areas. Over the long term, species ranges are expected to shift northward and the treeline will move to higher altitudes (Federal Council, 2015). Switzerland is fortunate to have many Alpine areas, which are believed to offer species a refuge from increased temperatures. A study found that plant, bird and butterfly communities at 500 m showed an average uphill shift of 8 m, 42 m and 38 m, respectively, over eight years (Roth et al., 2014). Some bird species, such as yellow-legged gull and European bee-eater, are expanding as a result of climate change (Federal Council, 2015). Butterflies, dragonflies, birds and several plant species from the Mediterranean are spreading into Switzerland (FOEN, 2017a).

Climate change is negatively affecting fish species, such as brown trout, which need cool temperatures to survive, and breeding birds in the alpine region. In Valais canton,

Figure 5.5. **Among OECD countries, Switzerland's shares of threatened species are high**



Source: OECD (2016a), "Threatened species", *OECD Environment Statistics* (database).

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Scots pine is being gradually replaced by downy oak due to drought linked to climate change (Federal Council, 2015). Extreme weather and mild winters are contributing to the spread of harmful organisms such as European spruce bark beetles, which damage trees. Between 1995 and 2005, 3.7 million m^3 of spruce wood was lost to infestations of harmful organisms (Federal Council, 2015).

Table 5.2. **The species diversity of vascular plants, and breeding birds in the Jura, is declining**

Species diversity, trends between 2005 and 2014

Biogeographical regions	Vascular plant developments	Breeding bird developments	Butterfly developments
Nationwide	↘	→	→
Jura	↘	↘	→
Central Plateau	↘	→	→
Northern Alps	→	→	→
Central Alps	↘	→	→
Southern Alps	↘	→	→

Source: BDM (2016), "Z12 Indicator, Status end 2012", Biodiversity Indicators, *www.biodiversitymonitoring.ch/en/home.html*.

Over time, climate change is expected to result in increased threats to species at both lower and higher levels of elevation. Lowland species will suffer from higher temperatures and drought, while alpine species will face increased competition and loss of habitat. Landscape fragmentation could also hinder species migration (Vittoz et al., 2012). To better understand the potential impact of climate change, Switzerland is undertaking a risk analysis of potential damage and gains expected by 2060 in the areas of health, agriculture, forestry, energy, tourism, infrastructure and buildings, water management, biodiversity and green spaces to identify priority areas for action at the national and regional levels.

3. Institutional, legal and strategic framework

As discussed in Chapter 2, Switzerland's political system can be characterised as highly decentralised, with significant delegation of powers to the cantons and municipalities under the subsidiarity principle. Non-government actors, whether private or from civil society, also have a say in government decisions via direct democracy in the form of referendums and popular initiatives. On biodiversity policies, the Confederation is responsible for setting the overall agenda and has jurisdiction over international commitments, subject to consultation with cantonal and municipal governments on implementation. This added level of complexity may partly explain Switzerland's occasional delays on international agreement ratifications and national strategies, and uneven national policy implementation.

3.1. Institutional framework

Government

Switzerland has a strong bottom-up governance system, with cantons having a high degree of autonomy in implementing environmental policy. Jurisdiction on biodiversity conservation, like most environment policies, is shared among the federal, cantonal and municipal levels of government. Broadly speaking, the Confederation sets overarching principles through acts and regulatory ordinances and provides financial support to the cantons for implementation. In turn, municipalities implement cantonal provisions through by-laws and local regulations on issues such as conservation and nature reserves. Programmatic contracts between the Confederation and the cantons, redefined every four years, are used to set management priorities and objectives. Thus the effectiveness of biodiversity policies and measures is highly dependent on effective co-operation among the three levels of government (OECD, 2007).

Within the Federal Council, nature protection and other biodiversity issues are mainly the responsibility of the Department of the Environment, Transport, Energy and Communications

and, under it, FOEN and the Federal Office for Spatial Development. An exception concerns agriculture-related issues, which fall under the Department of Economic Affairs, Education and Research and its Federal Office for Agriculture.

NGOs and the private sector

NGOs continue to be active players in biodiversity conservation and government policy development initiatives. They generate most of their funding from private donations, including membership fees, and the different government levels also provide core funding. In 2014, domestic NGOs spent CHF 55.4 million on biodiversity-related projects, excluding government support (CBD, 2016b). Swiss NGOs also manage 30 nature protection centres, which offer excursions, courses and exhibitions to some 200 000 visitors per year (SVS/BirdLife Schweiz, 2013). A programme to restore dry alpine grasslands is an example of how to achieve co-operation among stakeholders (Box 5.3).

Box 5.3. **The "Allegra Peter the Goatherd" programme: goats, donkeys and cattle graze for biodiversity**

More than 95% of Swiss dry grasslands and pastures have disappeared over the last century due to lack of grazing and maintenance, leading to a significant loss of biodiversity.

In 2006, Pro Natura, a Swiss conservation NGO, revived the character of Peter, the young goatherd from the famous Swiss children's book *Heidi*, through its "Allegra Peter the Goatherd" programme.

Working with farmers, local authorities and cantonal officials, Pro Natura launched several projects to prevent brushwood overgrowth and afforestation by reintroducing grazing animals to sustainably preserve dry grasslands in the alpine cantons of Valais and Grisons. Goats, donkeys and cattle are used, depending on the topography and type of overgrowth.

Between 2006 and 2016, more than 80 hectares of dry grasslands were restored through the programme. Traditional dry grassland floral species have returned, and the number and variety of butterfly species have more than doubled in one project.

Source: Pro Natura (2017), *"Allegra Pierre le Chevrier": des chèvres, ânes et autres bovins paissent pour la biodiversité, www.pronatura.ch/allegra-pierre-le-chevrier*.

The private sector also plays a critical role in determining how biodiversity is used and conserved. A number of progressive businesses are integrating natural capital values into their operations and investing in biodiversity protection. However, FOEN reported that attempts to co-operate with the private sector to assess private sector investment in biodiversity have had little success. Tracking private sector financial flows has proved very difficult due to lack of data accessibility, difficulty in identifying relevant activities and confidentiality issues. In addition, an attempt to obtain voluntary biodiversity data from private companies failed when only 2 companies provided quantified answers to a questionnaire sent to 249 companies (FOEN, 2015a).

There is evidence, however, that private individuals and organisations are donating or selling land of high ecological value to conservation organisations. For instance, the NGO Pro Natura has secured contracts, through a mix of transfers of ownership and conservation management services, with over 650 landowners for a total area of around 250 km^2, of which Pro Natura owns over 60 km^2. This makes Pro Natura the country's largest private landowner, its primary objective being to adequately protect habitats for animal and plant species (Pro Natura, 2016).

3.2. Legal framework

The Federal Constitution (1999) is the keystone of the legislative framework. It enshrines protection and conservation of the natural environment and landscape, notably in Article 78, which prescribes the Confederation's responsibility to legislate on animal and plant life protection, preservation of their natural habitats and diversity, and protection of endangered species from extinction.

Switzerland has a long tradition of biodiversity conservation, going back as far as 1876 with the Forest Inspectorate Act, which introduced early notions of sustainable management for the forestry sector through, notably, reforestation practices (Dictionnaire historique de la Suisse, 2015).

The modern biodiversity-related legislative framework rests on three main federal laws and their ordinances (FOEN, 2013a): the Act on Protection of Nature and Cultural Heritage (NCHA, 1966, last amended 2014), the Act on Hunting and Protection of Wild Mammals and Birds (1986, last amended 2014), and the Fishing Act (1991, last amended 2013).

The NCHA mandates the Confederation, cantons and municipalities to preserve habitats and heritage sites requiring ecological protection for native animal and plant species and for biotopes of high ecological value, and to mitigate the extinction of wildlife. Since 1991, red lists showing the extent to which species are threatened have been required under the NCHA.

Other federal laws taking into account the interests of nature conservation by protecting biodiversity and natural habitats include the Agriculture Act (1998, last amended 2015); the Forest Act, which introduced near-natural management for all forests (1991, last amended 2013); and the Spatial Planning Act (1979, last amended 2016).

In addition, an important milestone has been reached in water protection: the Water Protection Act (1991, last amended 2016) now contains provisions for restoring rivers and lakes so they can fulfil their natural functions and contribute to biodiversity conservation and promotion (EEA, 2015) (Chapter 4).

3.3. Strategic framework

The Swiss Biodiversity Strategy

Switzerland ratified the CBD in 1995 but did not submit a national biodiversity strategy until 2012, when the Federal Council adopted the Swiss Biodiversity Strategy after consultation with the cantons, civil society and the private sector. The strategy was developed according to the 2011-20 CBD Strategic Plan and generally followed the Aichi Biodiversity Targets' intent and structure, while taking into consideration the country's specific circumstances (FOEN, 2012a).

A central element of the strategy is the development of an "ecological infrastructure consisting of protected and connected areas" (Table 5.3, Strategic Goal 2). As per Section 2.2, landscape fragmentation and the poor state of ecosystems call for improved habitat protection and connection. This goal relates to Aichi Target 11, which requires at least 17% of a country's territory to be designated as protected area and protected. Section 4.1 discusses Switzerland's progress towards this target.

Also of note, Switzerland has pledged to strengthen its "commitment to the conservation of global biodiversity at international level" by 2020 (Table 5.3, Strategic Goal 9). This goal is not quantified, but includes "doing its part to fund project implementation at the global level

and particularly in countries of the South". Swiss biodiversity-related official development assistance (ODA) has been on a general uptrend in the past decade, reaching up to 4% of total ODA commitments, but is still lower than the OECD Development Assistance Committee average of 6% of total ODA in 2015 (Figure 5.6). Switzerland stated at the CBD 12th Conference of the Parties in 2014 that it would not meet the international commitment of doubling biodiversity-related ODA by 2015 but would try to meet it by 2020.

Table 5.3. **The Aichi Biodiversity Targets are reflected in the Swiss Biodiversity Strategy**

Reference	Target	Related strategic goals/Aichi targets
Strategic Goal 1	By 2020, the use of natural resources and interventions involving them are sustainable so that the conservation of ecosystems and their services and of species and their genetic diversity is ensured.	4, 7
Strategic Goal 2	By 2020, an ecological infrastructure consisting of protected and connected areas is developed. The state of threatened habitats is improved.	5, 8, 11, 14, 15
Strategic Goal 3	By 2020, the conservation status of the populations of national priority species is improved and their extinction prevented insofar as possible. The spread of invasive alien species with the potential to cause damage is contained.	9, 12
Strategic Goal 4	By 2020, genetic impoverishment is decelerated and, if possible, halted. The conservation and sustainable use of genetic resources, including that of livestock and crops, is ensured.	13, 16
Strategic Goal 5	By 2020, the negative impacts of existing financial incentives on biodiversity are identified and avoided, if possible. Where appropriate, new positive incentives are created.	3
Strategic Goal 6	By 2020, ecosystem services are recorded quantitatively. This enables their consideration in the measurement of welfare as complementary indicators to gross domestic product and in regulatory impact assessments.	2, 3, 20
Strategic Goal 7	By 2020, sufficient knowledge about biodiversity is available to society and provides the basis for the universal understanding of biodiversity as a central pillar of life, and for its consideration in relevant decision-making processes.	1, 19
Strategic Goal 8	By 2020, biodiversity in settlement areas is promoted so that settlement areas contribute to the connection of habitats, settlement-specific species are conserved and the population is able to experience nature in the residential environment and in local recreational areas.	4, 7
Strategic Goal 9	By 2020, Switzerland's commitment to the conservation of global biodiversity at international level is strengthened.	6, 10, 16, 18, 20
Strategic Goal 10	By 2020, the monitoring of changes in ecosystems and in species and genetic diversity is ensured.	17, 19

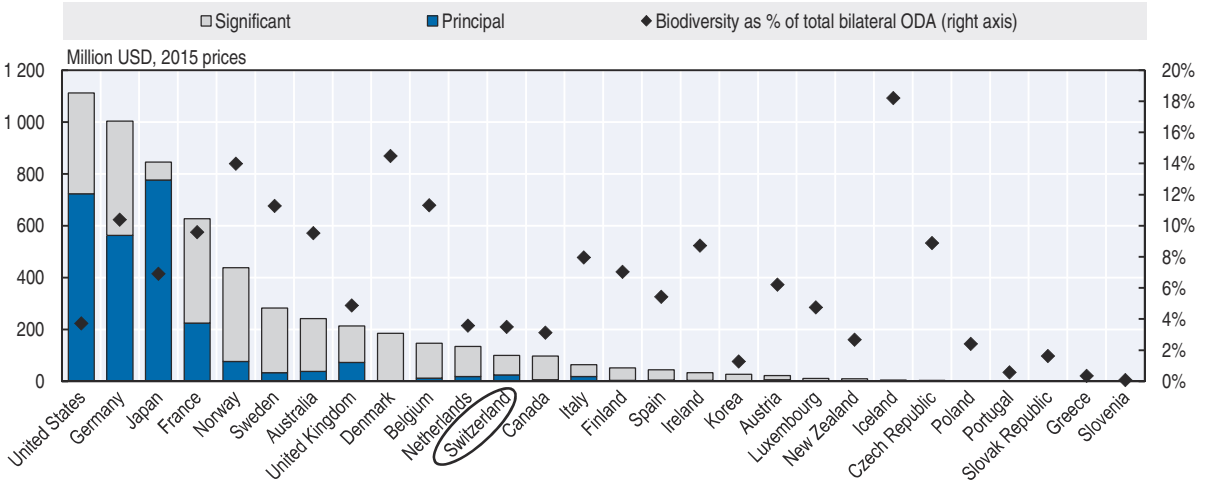
Source: FOEN (2012a), Swiss Biodiversity Strategy, *www.bafu.admin.ch/ud-1060-e*.

The other strategic goals are equally ambitious. Although the Swiss Biodiversity Strategy was never meant to be a detailed instruction manual on how to meet the goals, it provided few details on how they would be put into operation. The recent biodiversity action plan will thus be key in enabling domestic stakeholders and the international community to determine if Switzerland is going in the right direction.

Action plan

A 2010 CBD decision gave parties two years to submit a revised national biodiversity strategy (the first one, in Switzerland's case) and related action plan. Switzerland submitted its strategy on time but has only recently submitted its action plan. The Federal Council had asked FOEN to develop a plan by April 2014 to concretise the strategic goals, but it has taken more than three years past the target date for the council to approve the plan.

Figure 5.6. **Swiss biodiversity-related official development assistance is lower than in many other OECD countries**



Note: Bilateral biodiversity-related ODA, 2011-15 average.
Source: OECD (2017a), *OECD International Development Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933571872

Elaboration of the plan began in 2013 with an extensive, bottom-up collaborative process involving federal, cantonal and municipal authorities, the scientific community, farmer organisations, environmental NGOs and business organisations. A first set of 320 potential measures was identified through collaboration of over 650 experts from over 250 associations and organisations in all fields.

In the second phase, measures were consolidated and the relevant federal departments identified financial and legislative requirements. In February 2015, due to the complexity and broad implications of some of the proposed measures, the Federal Council decided that cantons needed to be further consulted and involved in the finalisation of the plan (FOEN, 2016b). The Federal Council finally approved the plan in September 2017. Financing of the action plan was approved in a context of limited access to new sources of funds, both at the federal and cantonal levels, which may result in incremental implementation of the plan.

Other policy frameworks

In addition to the Swiss Biodiversity Strategy and action plan, a few other policy frameworks and strategies on related environmental areas could benefit the state of biodiversity in Switzerland.

For instance, in May 2016 the Federal Council adopted an Invasive Alien Species Strategy (FOEN, 2016c) setting out principles, goals and measures to prevent and control such species, which are becoming a growing problem (Section 2.3). The strategy identifies knowledge and regulatory gaps and proposes measures that need to be taken to harmonise domestic and international action. The strategy reinforces the Confederation's intention to address the issue, which the biodiversity strategy lists as its third strategic goal (Table 5.3).

To address threats to species caused by a changing climate, the Federal Council approved a strategy, Adaptation to Climate Change in Switzerland, in 2012 and a 2014-19

action plan in 2014. This two-part national adaptation strategy identifies areas for action in various policy sectors, including biodiversity management. It calls for increasing monitoring of climate-sensitive species and habitats, expanding forest cover to minimise the impact of flooding and rockfalls, controlling the spread of the built-up area and rehabilitating watercourses (Federal Council, 2015).

4. Policy instruments for biodiversity conservation and sustainable use

The Confederation has implemented a number of instruments over the years to ensure biodiversity conservation and sustainable use. Over and above traditional regulatory approaches, economic instruments can provide alternative incentives and financing for programmes that benefit biodiversity and contribute to the inclusion of biodiversity in economic sectors.

4.1. *Direct regulatory instruments*

Protected areas

Habitat protection instruments are the main tool used to protect biodiversity (FOEN, 2017a). The protection level varies with the designation provided to a certain area. Taking only nationally protected areas into account, Switzerland has 6.2% of its territory protected under federal law. This is a low level by international comparison (Figure 5.7) and far from Aichi Target 11: adequate protection of at least 17% of terrestrial and inland water areas by 2020. Some 58% of the area under protection is in game reserves, a lower protection category originally intended to limit excessive hunting (FOEN, 2015b). The total area of nationally designated biodiversity areas increased from 29 449 ha in 1991 to 258 008 ha in 2011 but has since remained essentially constant. The types of ecosystem protected have evolved with time, however, with the addition of biotopes of national importance such as raised bogs, alluvial zones, fens, amphibian spawning sites, and dry meadows and pastures (Figure 5.8).

In addition to these formally protected national sites, there are other conservation areas that are not accounted for in the 6.2%, either because they overlap with nationally protected sites or because of missing data on the biodiversity protection level they offer. Adding in areas of international importance such as Emerald Network and Ramsar sites, regional and local conservation areas, forest reserves and biodiversity promotion areas on farmland would increase the share of the national territory designated for biodiversity conservation to around 12.5% (Figure 5.9) (FOEN, 2017a).

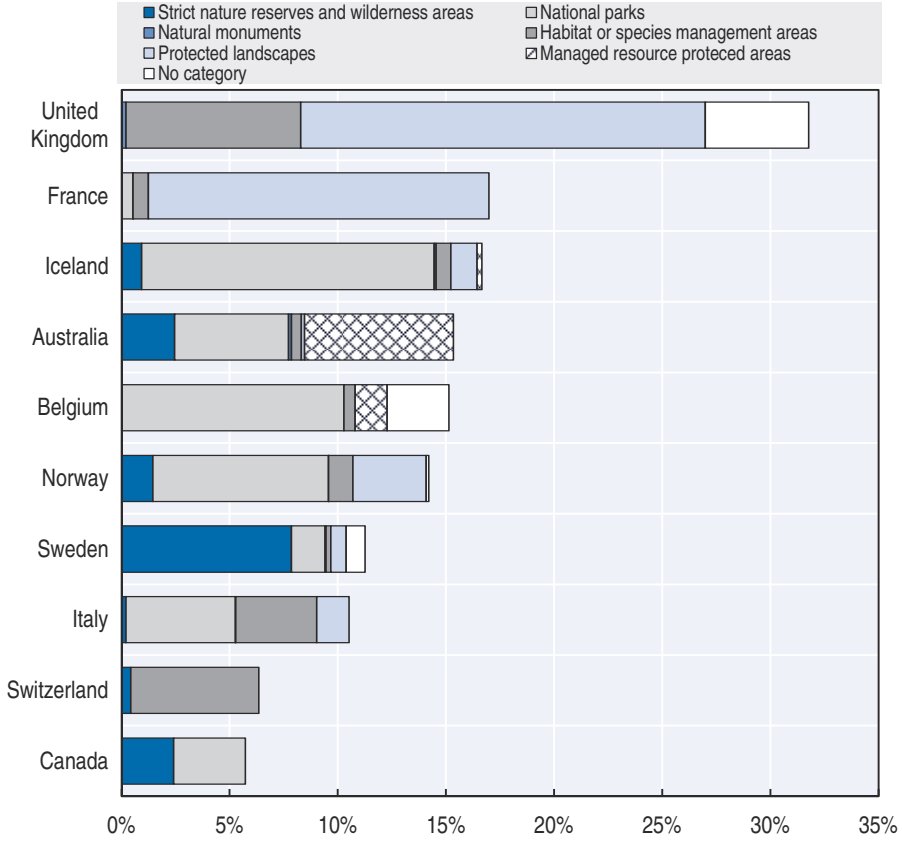
In addition to the issue of quantity, quality of protected areas is a challenge. The protected areas that do exist are often too small and poorly interconnected, and do not fully meet conservation objectives (FOEN, 2017a). Around 23% of protected areas lack a management plan (FOEN, personal communication). In 2014, only 58% of biotopes of national importance had protection and conservation measures in place (FOEN, 2017a).

Swiss parks

In 1914, Switzerland was one of the first European countries to create a national park. To this day, however, that remains the country's only national park, which is unusual for an OECD country (PNS, 2016). In November 2016, after 16 years of work with local authorities and conservation experts, voters rejected the creation of a second national park. A referendum on a smaller proposed national park is to be held in 2017. Plans for further national parks are being re-evaluated (Swiss Parks, 2016).

Figure 5.7. **Switzerland has lower levels of strict protected areas than other OECD countries**

Terrestrial protected areas by IUCN category, selected OECD countries, 2013 (% total area)



Source: OECD (2015a), Environment at a Glance 2015: OECD Indicators.

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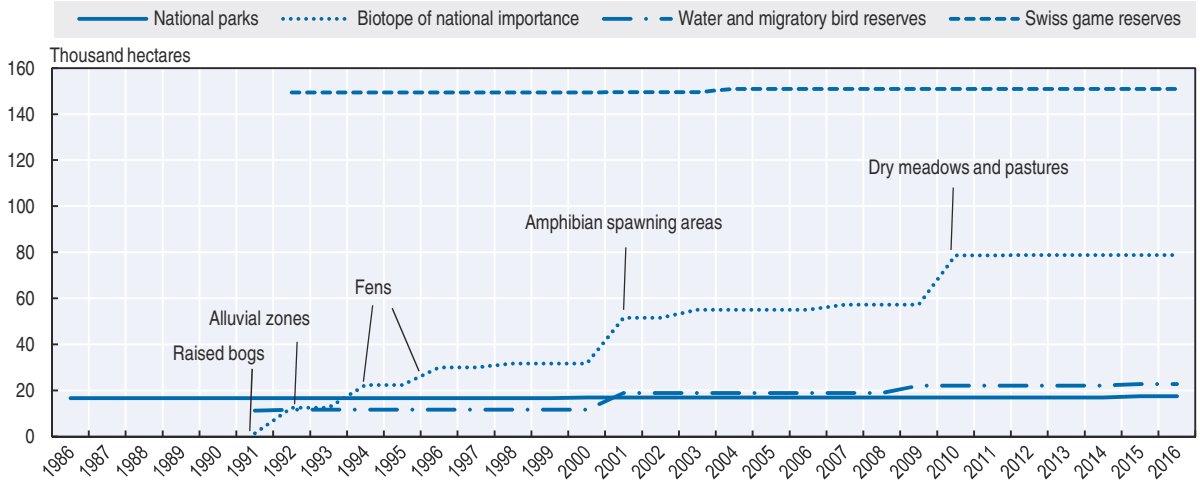
Figure 5.8. **Most protected area categories have seen little progress since 1990, except for biotopes of national importance**

Area of nationally protected sites, 1986-2016



Source: FOEN (2017), State of Biodiversity in Switzerland, Results of the Biodiversity Monitoring System in 2016, State of the Environment N 1630.

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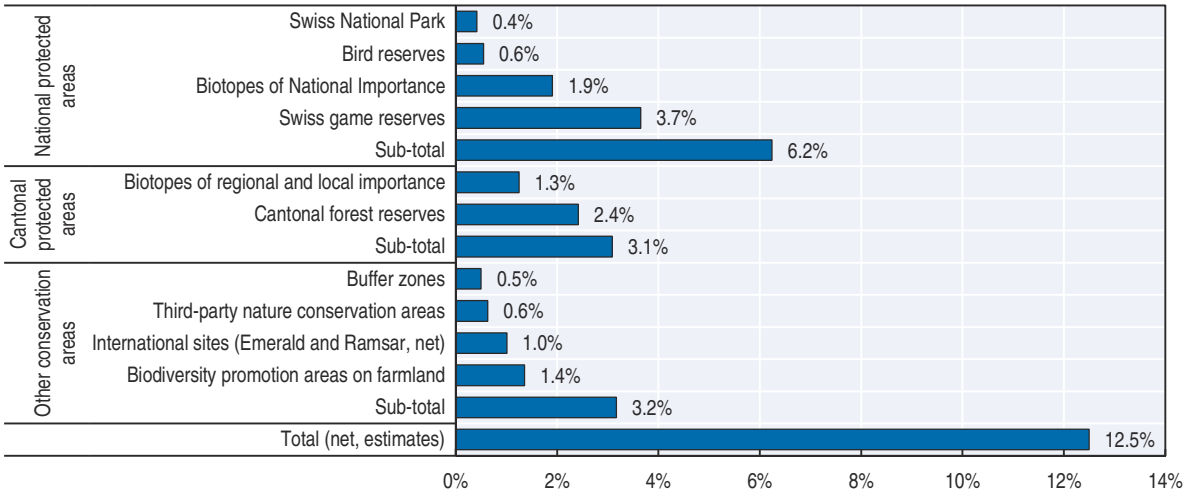
Figure 5.9. **Designated areas for biodiversity have varying levels of protection**

Share of the territory protected, by category



Note: Adjustments have been made to account for estimated overlaps

Source: FOEN (2017), State of Biodiversity in Switzerland, Results of the Biodiversity Monitoring System in 2016, State of the Environment N 1630.

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In response to a recommendation in the previous EPR, a legal framework for the creation of parks of national importance was adopted in 2007. It provides for park categories offering lower habitat protection than national parks: regional nature parks and nature discovery parks. Since then, 16 such parks have been established and 4 are being considered.

Emerald Network

As a party to the Bern Convention on the Conservation of European Wildlife and Natural Habitats, Switzerland is committed to protecting valuable natural environments through the Emerald Network, which applies to EU and non-EU countries alike. In 2009, the Confederation announced a first set of 37 candidate sites for the Swiss Emerald Network. However, all except on were already protected by federal or cantonal law (SVS/BirdLife Suisse, 2017).

The incremental conservation benefit of naming sites as part of the Emerald Network lies in ensuring connections between them. In this regard, Switzerland should ensure coherence between the network and river rehabilitation efforts undertaken since 2011 as water policy measures (Chapter 4). Connections also need to be improved with the Natura 2000 network in neighbouring EU countries. The EU and Council of Europe are co-operating towards concerted site conservation to develop Emerald and Natura 2000 into a pan-European ecological network with aligned standards by 2020.

4.2. Landscape management policies

Landscape management policies are an important tool to protect biodiversity and reduce habitat fragmentation, particularly where there are competing demands for land use. A study by the Biodiversity Forum of the Swiss Academy of Sciences estimated that one-third of the country's surface area should have conserving biodiversity and ecosystem services as its primary objective, and further efforts should be put into rehabilitation and restoration, in order to support long-term conservation (FOEN, 2014b). Switzerland has been making progress in integrating nature protection objectives into landscape management, but still

relies largely on subsidies, rather than regulations or economic instruments, for implementation at the cantonal and municipal levels.

Swiss landscape concept and Landscape 2020

In 1998, Switzerland developed the Swiss Landscape Concept to better consider the protection of nature, landscape and cultural heritage by integrating landscape policy into sectoral policies (FOEN, 1998). At the time of its publication, the concept was an innovative way to foster a dialogue between landscape users and conservationists. It helps mainstream landscape preservation in policies for sectors such as tourism, agriculture, nature protection, land use planning, transport and forestry. The concept is supported by the Swiss Landscape Fund, which provides funds for the protection and management of traditional landscapes, including enhancement of rural and urban landscapes, along with information sessions and training activities.

The Swiss Landscape Concept was a milestone in that it marked the beginning of an all-inclusive landscape policy in Switzerland. Landscape issues have since been increasingly considered, and legally binding instruments are available at the national level to require better and more effective actions in sectoral decision making. However, legally binding instruments are not yet used at the cantonal and municipal levels, where better alignment with federal objectives is needed (Jørgensen et al., 2016).

Switzerland signed the European Landscape Convention in 2000 but only ratified it in 2013 following years of political debate. Nevertheless, in 2003 Switzerland published Landscape 2020, a document that explicitly refers to the convention's definition of landscape and acts as a complement to the Swiss Landscape Concept. Landscape 2020 presents guiding principles to help federal agencies comply with the convention (Jørgensen et al., 2016).

Spatial planning, strategic environmental assessment and environmental impact assessment

Spatial planning, strategic environmental assessment (SEA) and environmental impact assessment (EIA) help in implementing policies related to landscape management and biodiversity conservation. The biodiversity strategy includes a commitment to improve co-ordination of sectoral policies relevant to spatial planning and integrate biodiversity into infrastructure policies and the planning, development and implementation of building projects (FOEN, 2012a). Because spatial planning mostly takes place at subnational levels, the Swiss Spatial Concept was developed jointly by the Confederation, cantons and municipalities as a policy framework to guide spatial development (Federal Council et al., 2012). One of its main objectives was to conserve and create space for biodiversity through spatial planning. The Spatial Planning Act was amended in 2013 to provide greater guidance for cantonal land use planning that supports biodiversity, seeking to reduce oversized development zones and better allocate reserves of development land (Federal Council, 2015). There is also a legal obligation to restore and provide compensation for degraded habitats deserving of protection under the NCHA (FOEN, 2012a). The federal inventories of mires, landscapes and natural monuments of national importance help support land use decision making that weighs a range of interests appropriately (Federal Council, 2015).

SEA and EIA are also important tools for mainstreaming biodiversity and other environmental considerations into policy and project decision making. As Chapter 2 noted, Switzerland has made limited use of SEA, EIA only seeks to verify whether larger projects

comply with environmental law, and smaller projects usually undertake simplified preliminary assessment. Addressing the gaps and inconsistent regional application of the current system of project approvals will be a key step in improving the status of vulnerable ecosystems and species that may not be adequately protected in existing laws. An inventory of all high-value habitats and ecosystems would help support improved spatial planning and EIA.

Urban development

Increased densification of built-up areas and the development of more protected areas in regions at risk of urban sprawl will be important to limiting impacts on biodiversity while not hindering economic growth on the Swiss Plateau. A commitment of the biodiversity strategy is to promote biodiversity within settlement areas so as to improve habitat interconnection, local species conservation and the public's ability to experience nature. One way to achieve this is through urban land use planning that designates green and open spaces in a multifunctional network (FOEN, 2012a). Swiss governments could look to examples such as France, which developed the Green and Blue Infrastructure initiative to reconstitute a network of corridors for animal and plant species (TVB, 2017). Yokohama in Japan uses a green tax on residents and corporations to pay for protection and expansion of green spaces (CY, 2013). A tax on building permits could also be considered as a source of funding.

Switzerland's decentralised governance model acts to encourage urban sprawl. The mix of federal and cantonal tax systems has repercussions on use of the territory as it influences land users and developers to assign a certain activity to the land, a multi-agency study found (Waltert et al., 2010). Its authors proposed a few minor changes to the tax system, including additional taxes on soil sealing and greenfield developments. Such taxes have been shown to be effective elsewhere to slow urban sprawl.

In contrast to countries such as the UK that contain urban growth with stringent land use restrictions and subject each planning application to review, Switzerland automatically allows developers to proceed as long as the land is zoned for that purpose. The fiscal system, which finances local goods provision through progressive income taxes, also provides strong incentives for municipalities to allocate large plots of land on the outskirts of the urban boundary to attract high-income taxpayers. Concerns related to the impact of urban sprawl on nature led to a ban on construction of new second homes in tourist areas. It was determined, however, that the policy had a negative impact on local economies, implying that alternative measures to limit urban sprawl may be preferable (Blöchliger et al., 2017).

Mountain development

Some 70% of Switzerland is mountainous. For decades, the policy has been to avoid widespread depopulation of the mountains, where dry grassland habitats are being lost due to abandonment of pastures and associated forest encroachment. Public financial support promotes sustainable development in the mountains. In particular, farmers in mountain areas receive significantly higher agricultural income support than their lowland counterparts. In addition, the fiscal equalisation system requires financially strong cantons to support financially weaker cantons, to the benefit of many mountainous cantons.

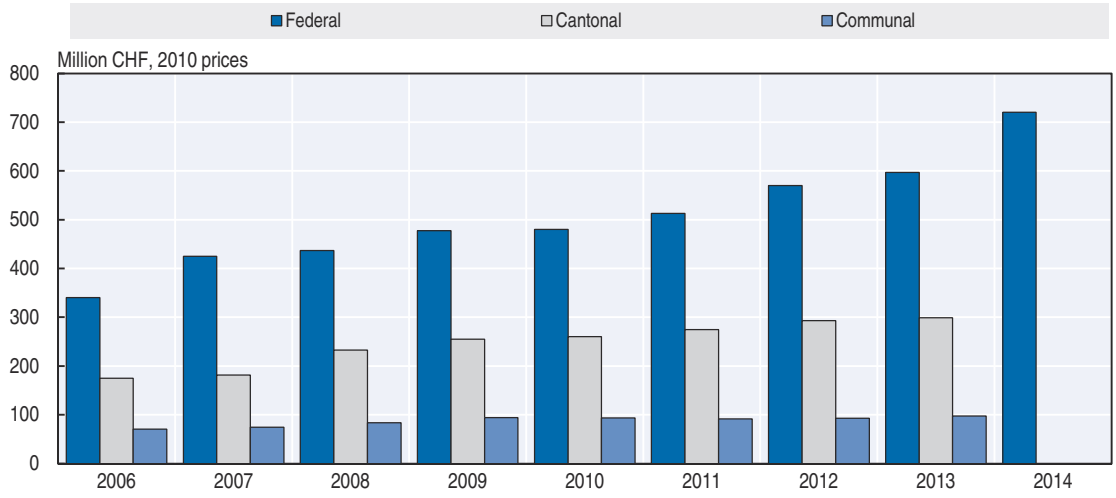
Switzerland is part of the world's only legally binding regional agreement for mountain protection, the Alpine Convention, along with Austria, France, the European Community, Germany, Italy, Liechtenstein, Slovenia and Monaco. Nine protocols detailing the requirements of the framework agreement have been developed, concerning mountain

agriculture; nature protection and landscape conservation; land use planning and sustainable development; mountain forests; tourism; soil conservation; energy; transport; and dispute settlement. While Switzerland signed the protocols, it is the only country not to have ratified them (AC, 2017). The Federal Council submitted the protocols to the parliament in 2001, but after years of consultation, ratification was rejected. Nevertheless, Switzerland adheres to the protocols in practice, and has incorporated the requirements into law (ARE, 2017).

4.3. *Public financial support*

Public expenditure on biodiversity by all three levels of government increased significantly in the past decade; it exceeded CHF 1 billion in 2013 (Figure 5.10). In particular, federal public expenditure more than doubled over the period, reaching CHF 700 million in 2014. Public expenditure included here consist of biodiversity-related budgets for ministries and research organisations, and the biodiversity-relevant share of agricultural direct payments (Sections 4.4, 5.1), which explains the large federal contribution.

Figure 5.10. **Public expenditure on biodiversity increased significantly over 2006-14**



Note : Cantonal and municipal data are not available for 2014.
Source: CDB (2017), Financial Reporting Framework Clearing-House Mechanism.

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Nevertheless, current financial resources, despite the increase, remain insufficient to ensure protection and restoration of important ecosystems and species. The shortfall in resources may partly explain the failure to meet biodiversity targets. In 2013, FOEN estimated that implementing measures to meet the objectives of the biodiversity strategy would lead to an annual funding gap of CHF 182 million to CHF 210 million by 2040 (CBD, 2017). This situation led to a Federal Council decision in May 2016 to invest CHF 135 million – an additional CHF 55 million, plus CHF 80 million through repurposing from the FOEN budget – in urgent biodiversity measures over 2017-20.

In 2008, a fiscal equalisation reform introduced requirements for federal budgetary transfers to the cantons. Since then, the Confederation and cantons have had to prepare joint programme agreements describing, among other matters, environmental challenges in the cantons and measures to address them. FOEN then determines the amount of federal transfer for a particular cantonal nature conservation programme, based on goals

and targets as well as indicators to monitor progress (SIB, 2014). Confederation support to cantonal biodiversity activities is expected to double compared to 2008-11 levels, reaching up to CHF 60 million per year between 2016 and 2019.

4.4. *Economic instruments*

Economic instruments, such as environmentally related taxes and charges, payments for ecosystem services and biodiversity offsets, can be a cost-effective way for governments to address environmental issues, including threats to biodiversity and ecosystems. They can offer economic agents greater flexibility than regulations (e.g. command-and-control approaches) in the way they respond to environmental objectives, thus enabling objectives to be attained at lower total economic cost. Some – such as taxes, charges and user fees, and tradable emission permits that are auctioned – can also generate revenue that can be earmarked for further biodiversity conservation and sustainable use measures.

Switzerland makes little use of economic instruments in its efforts to protect biodiversity, with the noticeable exception of agricultural direct payments for biodiversity promotion areas (Section 5.1), which can be likened to payments for ecosystem services. Few other examples exist in Switzerland, which puts greater reliance on regulatory measures to meet challenging biodiversity objectives. Numerous opportunities exist for expanding the use of economic instruments, such as taxes on pesticides and ammonia emissions in agriculture, payments for ecosystem services in the forestry sector (Section 5.2), access fees in tourism and urban taxes to finance additional green spaces (Section 4.2).

Biodiversity offsets

Biodiversity offsets, also known as conservation offsets, are economic instruments (based on the polluter-pays approach) whereby developers must compensate for unavoidable biodiversity loss when projects of overriding public interest are allowed to go ahead. Good practice requires such offsets to be the final step of a mitigation hierarchy: first, avoiding or minimising negative impacts on biodiversity; then restoring unavoidable impacts at the site; and finally, as a last resort, offsetting residual impacts elsewhere. This should ensure no net loss of biodiversity, but can also require net gain. The NCHA requires reconstitution or replacement of protected biotopes where impacts are unavoidable. If, after all factors are taken into consideration, it is impossible to avoid harm to protected biotopes, the developer must take special measures to ensure the best protection possible, reconstitution, or, if this is not possible, adequate replacement (ten Kate et al., 2004). A compensation site must be in the same area and be equivalent (i.e. have the same ecological function). Metrics for compensation are published and the cantons are responsible for ensuring long-term quality. Finding suitable areas for compensation is becoming increasingly difficult and pools of areas where compensation could take place are being considered (habitat banking). Some cantons and authorities have the expertise to oversee these processes well, while others lack the human and financial capacities. Biodiversity offsets' most common application is in the extractive industries, of which Switzerland has few, but other applications could be imaginable and desirable (e.g. ski resorts, infrastructure) (Sections 5.4 and 5.5) (OECD, 2016b).

Taxes

Governments can use environmental taxes or tax exemptions to promote desirable environmental practices while raising revenue. Biodiversity-related taxes or charges could

include, for instance, entrance fees to protected natural areas and taxes on fertiliser and pesticide use (OECD, 2013).

One biodiversity-related tax exemption was applied by the Federal Council in 2008. A hefty oil tax (above the OECD average) is applied to petrol, diesel fuel and heating oil imported to Switzerland. The Confederation passed an exemption for fuel produced from renewable feedstock (biofuel) provided that biofuel suppliers can demonstrate a positive overall environmental impact and socially acceptable production standards. Three ecological requirements must be met to qualify for the exemption, including one specific to biodiversity: the cultivation of raw materials must not jeopardise tropical forest preservation and biological diversity (OECD, 2013).

4.5. *Subsidies harmful to biodiversity*

Switzerland has recognised the challenge posed by environmentally harmful subsidies and has committed to look into it as part of its biodiversity strategy goals for 2020 (Strategic Goal 5). An initial study (Rodewald and Neff, 2001) estimated that one-third of all federal financial measures potentially qualify as environmentally harmful. In 2013, in the course of work to develop the Agriculture Policy 2014-17, a study commissioned by FOEN identified a set of such subsidies and recommended further work on incentives, such as support for tourism infrastructure (Ecoplan, 2013).

4.6. *Information measures*

A recent poll showed that a large majority of Swiss believe nature is doing very well and the country is past the degradation stage and into recovery (FOEN, 2017a, Schaub and Welte, 2017). This misperception of the risks facing biodiversity may contribute to biodiversity protection being given low priority vis-à-vis economic development objectives.

Both NGOs and governments have a role to play in informing and educating the population. For instance, Info Species is a network of Swiss data centres to document biodiversity for fauna, flora, lichens and fungi. Through this network, researchers, cantonal and federal agencies, and the public have easy and efficient access to over 15 million observations stored in a single database (Info Flora, 2017).

5. Mainstreaming biodiversity into economic sectors

Many pressures on biodiversity result from activities influenced by sectoral or other policies that do not have biodiversity as their primary focus. Overall, Switzerland has made progress in mainstreaming biodiversity at the level of strategies and federal policies, but needs to do more to translate general declarations of intent into concrete measures at all levels of government, particularly in relation to pesticides and ammonia emissions from agriculture, forest conservation and mitigating the impact of tourism and transport infrastructure.

5.1. *Agriculture*

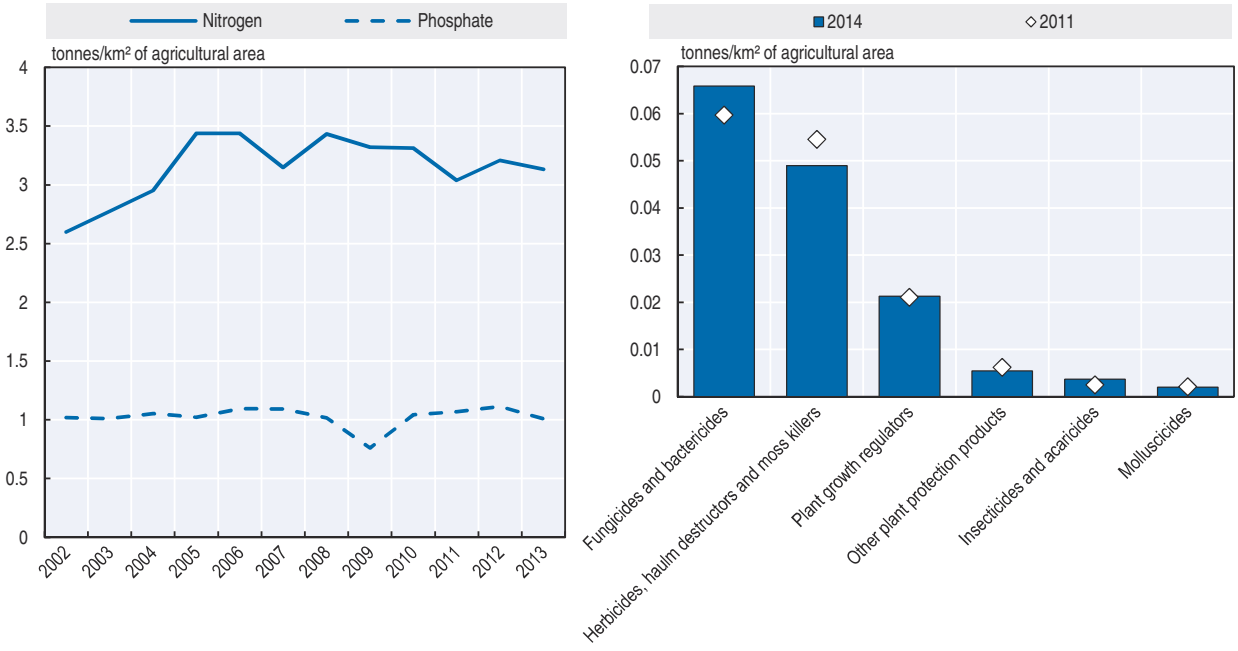
Trends relevant to biodiversity

Over the years, intensive agricultural practices have greatly affected habitat diversity on agricultural land. To facilitate industrial farming, biodiversity-friendly structures have been removed, wetlands have been drained or filled in, nutrient-poor land has been fertilised and dry sites have been irrigated. All this has been devastating for habitat diversity. It has been

estimated that 35% of the habitat types in agricultural areas are assessed as threatened (FOEN, 2017a).

The agriculture sector is a significant contributor to water, soil and air pollution, which is a risk to both terrestrial and aquatic biodiversity. Pesticide sales in Switzerland, currently ranking in the middle of OECD countries, remained stable between 2011 and 2014, despite a decrease in hectares used for agriculture (Figure 5.11) (FOEN, 2014b). Nitrogen fertiliser use remained high between 2002 and 2013, keeping pressures on water quality in agricultural areas (Figure 5.11). As a result, nitrate levels continue to be elevated in groundwater of the Swiss Plateau (SCNAT, 2016b). Agriculture is also responsible for around 20% of consumptive water use even though only 3.4% of the agricultural area is irrigated (SCNAT, 2016b).

Figure 5.11. **Nitrogen fertiliser use remains high while pesticide use has stabilised**



Source: EUROSTAT (2017), *Pesticide sales* (database) ; EUROSTAT (2017), *Consumption of inorganic fertilizers* (database); FAO (2016), *FAOSTAT* (database).

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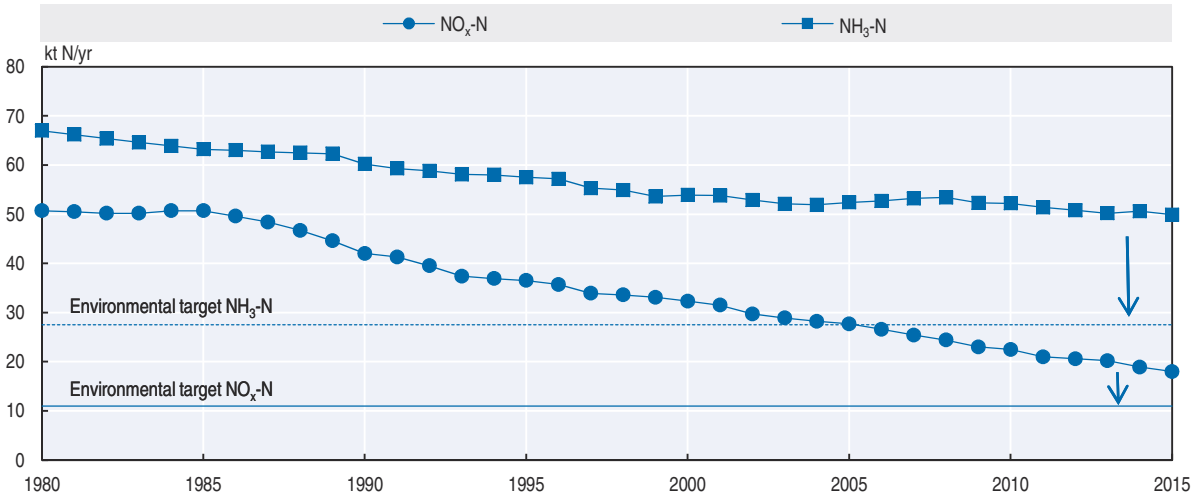
Agriculture is the main contributor to ammonia emissions: it is responsible for 92% of them, and the level is relatively little improved over the past two decades (Figure 5.12) (ES, 2015). Combined with high levels of NO_X, ammonia pollution in the air is causing eutrophication of many ecosystems. In particular, the impact is felt on the Swiss Plateau on 100% of all raised bogs, 84% of fens and 42% of dry meadows and pastures (Federal Council, 2015). No less than 90% of the forest area is adversely affected by excessive nitrogen loads (FOEN, 2014b). Ammonia comes primarily from agricultural livestock waste management and fertiliser use, while NO_X emissions come from fossil fuel combustion (FOEN, 2014b). Soils highly loaded with nutrients such as nitrogen result in less diversity (homogenisation) of local plant communities (FOEN, 2014b).

However, agriculture can also be beneficial to biodiversity, with grazing cows, sheep or goats slowing down the loss of biodiversity-rich grasslands to forest (BDM, 2016). As Section 1 noted, biodiversity-rich dry meadows and pastures lost around 95% of their area between 1900 and 2010 (FOEN, 2017a). In 2011, Switzerland averaged 1.2 head of livestock per hectare

Figure 5.12. **Ammonia emissions have declined more slowly than NO_X emissions**



Source: OFEV / IIR (2016) ; SLPA (2009).

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of utilised agricultural area, but in some central and eastern cantons livestock numbers exceed 1.5 head per hectare, which is rather high by European standards (BMD 2016).

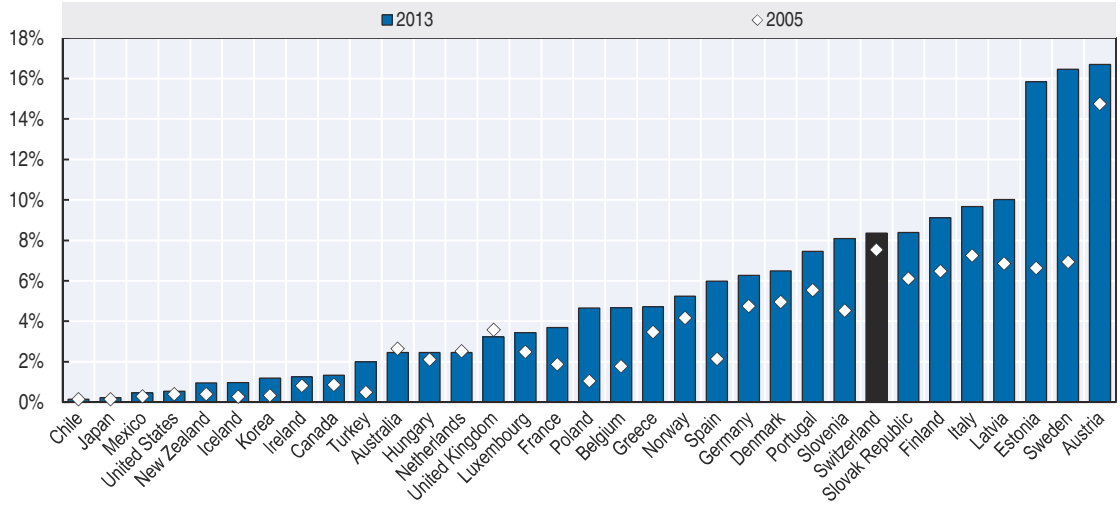
An increasing trend towards organic farming has the potential to be beneficial to biodiversity by limiting use of chemical or synthetic fertilisers or pesticides as well as limit livestock density (though in some cases it may increase ammonia emissions and nitrate leaching from manure). In 2014 Switzerland had strong demand, with the world's highest per capita organic food consumption (OE, 2014). However, while organic farming increased significantly between the early 1990s and 2005, growth has since slowed, allowing countries such as Sweden to surpass Switzerland's previous high levels (Figure 5.13). Mountain cantons are leaders in organic farming, with the largest areas in Graubünden and Bern. In 2015, 13% of Swiss agricultural land was farmed organically (FOEN, 2017a). Organic farming is easier in the mountains, where there is primarily grassland, than on lower altitude farms that cultivate cereal or specialised crops (BDM, 2016).

Agricultural policy

Environmentally responsible farmers use a private eco-labelling initiative, IP-SUISSE, to attract consumers increasingly demanding environmental accountability. IP-SUISSE is an association of over 20 000 farmers who produce food using environment-friendly processes. To be certified, farmers must demonstrate that their production is free of genetically modified organisms and produced with limited and controlled amounts of fungicides and pesticides. One study showed that farmers following IP-SUISSE's guidelines had seen increases in species on their land of 33% for plants, 20% for butterflies and 12% for birds (Zellweger-Fischer and Birrer, 2015).

Switzerland reformed its agricultural support in the 1990s to reduce production distortions from market price support and require proof of ecological performance. While the level of farm support has gradually fallen, producer support remains among the highest in the OECD. However, the reforms have allowed for targeting certain regions, such as mountainous areas losing biodiversity-rich grasslands (OECD, 2015b; OECD, 2017b).

Figure 5.13. **Switzerland, an early leader in organic farming, has been overtaken by other OECD countries**



Note: 2005 and 2013 or closest available years.
Source: FAO (2016); *FAOSTAT* (database).

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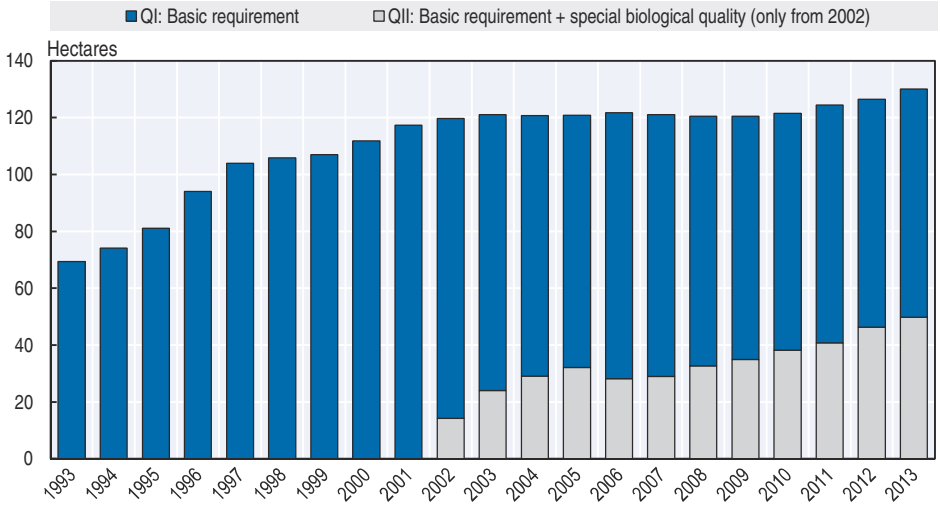
Environmental cross-compliance (direct payments to farmers tied to ecological performance) was introduced in 1993 and strengthened in 1999 to encourage, among other things, conservation and promotion of biodiversity in agricultural areas (OECD, 2010). To be eligible for direct payments, farmers must provide evidence of good ecological performance, including allocating at least 7% of agricultural land (3.5% for special crops) as biodiversity promotion areas (which until 2014 were called ecological compensation areas). Between 1993 and 2013, such areas increased in total size from 70 000 to 130 000 ha, accounting for 12.4% of the utilised agricultural area (Figure 5.14). In 2015, they covered around 15% of the utilised agricultural area, which demonstrates the incentive effect of the payments.

The strong participation of Swiss farmers in the biodiversity promotion areas programme reflects significant demand for this type of policy incentive. Two case studies conducted in the early 2000s by the Swiss Federal Research Station for Agroecology and Agriculture revealed that species diversity is higher on such areas than on intensively farmed land (FOEN, 2012b). However, a survey of compliance with agri-environmental targets set since 2008 showed that the sector had not attained the majority of objectives relevant to biodiversity, particularly in terms of quality and interconnection of habitats and ecosystems. The review highlights the need for greater efforts to maintain biodiversity in mountain regions and improve it at lower elevations (FOEN and FOAG, 2016).

Agriculture Policy 2014-17 reallocates direct payments to more closely align them with specific objectives, including biodiversity conservation. It also eliminates payments per head that had encouraged intensification of cattle farming (FOEN, 2014b). Agricultural direct payments totalled CHF 2.8 billion in 2015, of which payments for activities that explicitly support biodiversity conservation reached CHF 396 million, or 12% of all direct payments (OECD, 2016c). Additional work is needed to ensure that the remaining 88% have no harmful biodiversity effects.

Control of ammonia emissions falls under air policy. There are no specific agricultural payments to tackle ammonia pollution from agriculture, but many agricultural payments

Figure 5.14. **Biodiversity promotion areas (formerly ecological compensation areas) are eligible for direct payments**



Source: OFEV (2016b), Stratégie et plan d'action pour la biodiversité.

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implicitly address it. There are technical regulations for manure storage and treatment (Federal Council, 2015). Pesticide use can also be subject to restrictions, such as maintaining a certain distance from surface water bodies. The Federal Council is considering a broader action plan to minimise pesticide risk to water bodies (Federal Council, 2015).

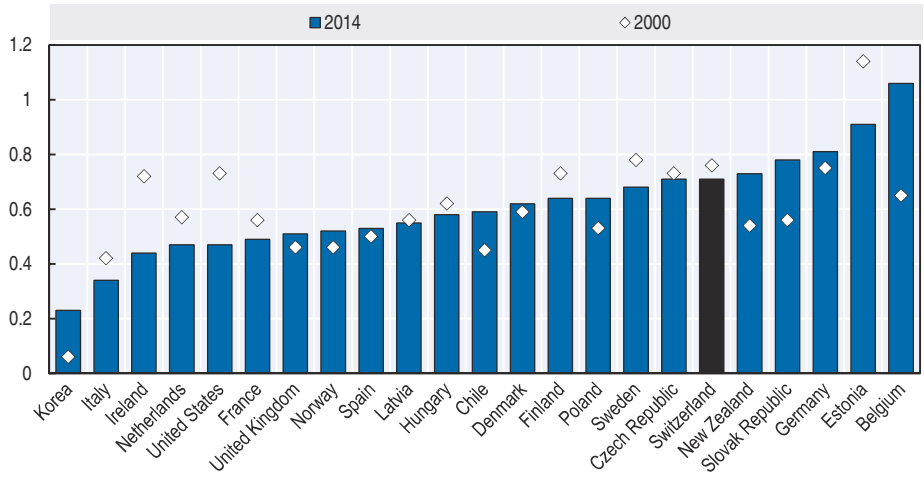
While agricultural policy reforms are moving in the right direction, more effective policies are needed to limit pesticide use and ammonia emissions in the sector, such as more directly tying of support payments to environmental performance and introducing regulations or taxes to control pesticides and ammonia (OECD, 2015a), something the government seems to be considering through an introduction of taxes on pesticides and farm nitrogen surpluses as of 2021 (Chapter 4).

5.2. *Forestry*

Trends relevant to biodiversity

Swiss forests are particularly important to biodiversity. Around 60% of the over 50 000 plants, animals, fungi and bacteria in the country rely on forest ecosystems (FOEN, 2013b). The forest area was reduced over the 19th century to a low of 0.7 million ha, but forests now represent 31% of Switzerland's surface area, or 1.28 million ha (FOEN, 2014b). Pressures on forests continue on the Swiss Plateau as a result of increasing population and infrastructure development as well as pollution and invasive species. Switzerland has higher levels of threatened forest-occurring mammals and fungi than other European countries but similar levels of other species (FAO and EFI, 2015). In general, the trend is towards forest regrowth at higher altitudes and forest loss at lower altitudes (FOEN, 2014b). Between 1995 and 2013, an average of 7.3 million m^3 was harvested annually, and an additional 1.8 million m^3 was lost to natural hazards (Federal Council, 2015). The Confederation is looking to increase the annual wood harvest, encouraging wood use as a low-carbon alternative to concrete, steel and fossil fuels (Federal Council, 2015). Switzerland already has one of the OECD's highest levels of forest resource use intensity (Figure 5.15). The total length of forest roads travelled by trucks

Figure 5.15. **Intensity of forest resource use is relatively high**



Note: 2000 and 2014 or closest available years. The indicator is a ratio of actual fellings to annual productive capacity (i.e. gross increment).
Source: OECD (2016a), "Depletion and growth of forest resources in terms of volume", *OECD Environment Statistics* (database).

StatLink http://dx.doi.org/10.1787/888933572043

has increased by 969 km since 1995, contributing to landscape fragmentation (Section 1) (FOEN, 2017a).

Swiss forests are coming closer to natural regeneration, however, with 90% of mature timber established by natural seeding and a growing share of fallen and standing deadwood (largely a result of the 1999 "Lothar" windstorm) that provides species habitat. As a result, breeding birds relying on forest habitat are increasing in numbers and some larger predatory mammals such as wolves and bears are returning. The proportion of endangered species in forests is lower than in other ecosystems (FOEN, 2014b). While the situation has improved, there are not enough old forests, forests with high levels of deadwood, highly structured forest edges and young well-lit young forests to support biodiversity (Federal Council, 2015).

Forestry policy

The 1876 Forest Inspectorate Act prohibiting clear-cutting was a turning point in reducing forest loss (FOEN, 2014b). While it does not allow for a decrease in forest area, it does allow options for compensation of forest losses, such as offsets (FOEN, 2014b). The 1991 Forest Act required increased standardisation of all cantonal regulations (Angst, 2012). Forest Policy 2020, adopted by the Federal Council in 2011, includes biodiversity conservation and improvement as an objective. The policy is founded on the principle of near-natural silviculture, which promotes natural regeneration where possible, tailors tree species to local conditions, conserves and promotes forest habitat diversity and protects the natural soil fertility. It also promotes interconnection of forest ecosystems, with each other and with other ecosystems, to improve biodiversity conservation (FOEN, 2012a; Angst, 2012). Over 50% of the Swiss forest area is certified through harmonised criteria of the Forest Stewardship Council and the Programme for the Endorsement of Forest Certification (FOEN, 2017a).

National forest policy implementation was initially supported by subsidies for afforestation and promoting the use of wood as a building material. In the 1980s, support was extended to include mountain forest management. Financial support to the forestry sector is around CHF 135 million per year. When cantonal contributions are included, the

amount increases to about CHF 230 million. Around 46% of federal funding is for forest protection, 30% for protection against natural hazards, 10% for forest management and 7% for forest biodiversity. An additional CHF 20 million was added in 2016 for adaptation to climate change. Forest Policy 2020 recommended increasing biodiversity-related payments in the forest sector from the current CHF 10 million a year to about CHF 38 million. The cantons vary in terms of how they distribute their contributions across categories. Implementing the forestry components of the biodiversity action plan will require an increase in subsidies or other measures (FOEN, 2015c).

Subsidies also exist for protection of mountain forests, which provide important ecosystem services, such as natural habitat for many species and a barrier against avalanches and other hazards. Half the Swiss forest area has protective functions whose maintenance costs are a fraction of what construction of hazard protection structures would cost taxpayers. Forest managers are obligated to monitor and improve forest structure, with costs covered by a mix of funding from all three government levels. The amount of assistance is determined by the protective area to be maintained, the risk to be avoided and the impact of the measures, leading to a large variation in the amounts – from CHF 3 000 to CHF 43 000 per hectare (Losey, 2014). On average, the Confederation allocates CHF 60 million per year for protective forest.

While subsidies encourage forest protection, the policy of increasing annual wood harvesting rates is potentially inconsistent with the biodiversity objectives in Forest Policy 2020 and commitments to protect 8% of forest by 2020 and 10% by 2030. Careful policy implementation is required to ensure coherence, protecting areas of high value to biodiversity while maintaining harvest rates at sustainable levels. Only 5.6% of the forest area is protected as forest reserves, and Switzerland has among the lowest levels of forest protection in Europe (FAO and EFI, 2015). Further effort beyond subsidies is needed to increase protection of forested areas, particularly those that are of high biodiversity value, and to minimise forest landscape fragmentation and species habitat disturbance while increasing elements beneficial to biodiversity, such as deadwood volumes. Expanding protected areas in forest ecosystems is important, but Switzerland could also consider fees and payments for ecosystem services (paid by forest users) reflecting forests' value in terms of CO_2 removal, oxygen production, water purification, climate modification, soil stabilisation, water regulation and wind breaks. Such a regime could discourage harvesting in high-value ecosystems while raising revenue for additional conservation programming.

5.3. Energy

Trends relevant to biodiversity

The planned shift away from nuclear power towards hydropower, other renewables, cogeneration and gas-fired power could harm biodiversity if not managed carefully. Hydropower generation can significantly affect aquatic ecosystems and water use, and wind turbines may pose a threat to birds. Irregular water discharges from hydropower plants (hydropeaking) disrupt aquatic organism habitats downstream (BDM, 2016). Hydroelectric plants account for 50% to 60% of the electricity produced in Switzerland. Some experts say that more than 90% of watercourses that can be exploited are already used for hydropower production. Others contend that only about 30% of the total energy contained in Swiss rivers is currently used to generate electricity, and it may be possible to increase the share without relaxing environmental and water protection laws. All in all, the more informed estimates concur that there is about a 10% hydropower production increase potential by 2050

(SCNAT, 2016b, Chapter 4). Wind represents a relatively small share of electricity production but there is potential to increase it, with attractive sites in the Jura and Alps (SFOE, 2016).

Hydropower stations cause insufficient residual water volumes in many locations and affect natural conditions with their alteration between water surge and low flow. While newly licensed hydropower plants must meet tight minimum flow requirements, much less stringent requirements apply to existing plants (Federal Council, 2015).

Energy policy

Energy Strategy 2050 requires minimisation of conflict between energy projects and biodiversity through guidelines for energy project development on top of EIA requirements (Section 4.10) (FOEN, 2012a). For example, any hydropower expansion must take valuable water bodies into consideration and have capacity greater than 1 MW so as to limit the number of facilities (Federal Council, 2015). The 2011 amendments to the Water Protection Act also require reduction of hydropeaking, sediment transport changes and fish migration obstacles by 2030, with provision for compensation for rehabilitation costs (paid via a surcharge on high-voltage power transmission networks) (Federal Council, 2015) (Chapter 4).

5.4. Tourism

Trends relevant to biodiversity

Tourism is an important sector of the economy, providing 4.6% of export revenue in 2013 (FST, 2014). Biodiversity is a key factor in the tourist industry; for instance, monetary estimates of the recreation value of forests are around CHF 10 billion (FOEN, 2014b). Ecosystem deterioration can pose a risk to tourism. In Lake Zurich, for example, warming waters combined with excess nutrients led to an explosion of algae, including a cyanobacterium that can harm humans, fish and wildlife (Rex, 2013). Tourism can also hurt biodiversity, with sport and recreation in alpine and subalpine regions being a particular risk (Box 5.4) (Fischer et al., 2015).

Box 5.4. **Outdoor snow sport affects black grouse in the Alps**

In 2013, the University of Bern published a case study on the impact of snow sport on black grouse in the Alps. The Alps, which form part of nearly a dozen European countries, are the top global destination for winter activities such as skiing and snowboarding, with the number of ski resorts and off-trail backcountry activities continuing to grow.

The black grouse was selected as an indicator species to demonstrate the impact of sport on alpine wildlife. The bird is an ideal species to assess, since it inhabits the treeline ecosystems where most outdoor winter sport takes place and is highly dependent on the habitat for reproduction.

Researchers measured the birds' stress hormone in faeces collected from snow burrows to assess their stress response to human disturbance. They found that black grouse living in natural treeline habitats had significantly lower concentrations than those in ski resort areas or areas with backcountry activities. The findings imply that the birds need areas with almost no disturbance to avoid negative effects.

They also found that the black grouse moved away from areas with snow sport, using them less frequently or abandoning them altogether. While the impact was lower with backcountry activities, the activities covered a larger area than ski resorts.

Box 5.4. **Outdoor snow sport affects black grouse in the Alps** *(cont.)*

The authors identified 31 critical conflict zones in Switzerland's Valais canton that should be priorities for wildlife refuges free of disturbance, such as those established near ski resorts in Germany's Bavarian Alps. They recommended refuges of about 40 ha that are clearly marked, combined with information provision and education as well as fines for not respecting the boundaries. The creation of refuges would benefit not only the black grouse, but also other alpine wildlife threatened by the expansion of snow sport.

Source: Arlettaz et al. (2013), *Impacts of Outdoor Winter Recreation on Alpine Wildlife and Mitigation Approaches: A Case Study of the Black Grouse, www.researchgate.net/publication/258689301_Impacts_of_Outdoor_Winter_Recreation_on_Alpine_Wildlife_and_Mitigation_Approaches_A_Case_Study_of_the_Black_Grouse.*

Tourism policy

The Swiss Biodiversity Strategy includes a commitment to integrate biodiversity into sport and tourism policy, promoting nature-compatible services and infrastructure. It also calls for more controls on tourism, sport and leisure activities by setting conditions and limiting visitors in ecologically sensitive areas. A further commitment in the strategy is to protect remote areas from large visitor volumes by conserving and creating attractive local recreational areas as alternative destinations (FOEN, 2012a). Commitments to reconcile tourism with nature protection are also included in the FOEN sport and tourism strategy (2010-12), the Landscape Concept (Goal 3) and the Federal Council's growth strategy for Switzerland as a tourist destination (2010). However, none of the strategies provide details on actions, other than provision of working groups and educational material.

More specific and targeted efforts will be needed to protect biodiversity from expanding tourism, particularly in previously undisturbed areas, as well as to reconcile tourism development ambitions with biodiversity protection (a shortcoming in the recent referendum on a second national park). The German approach of establishing wildlife refuges on the margins of ski resorts could be considered, for example, if biodiversity were adequately integrated into land use planning and EIA processes. There is also scope to introduce or increase fees for tourism operators in biodiverse (often remote) mountainous areas.

5.5. *Transport infrastructure*

Transport infrastructure, including roads and railways, is a significant contributor to landscape fragmentation, which limits the freedom of movement of wild animals, amphibians, reptiles and small mammals, increases the risk of accidents from traffic and reduces habitat size (BDM, 2010). Air pollutants, noise and light disturbances can also harm biodiversity (ARE, 2016). Swiss transport infrastructure covers around 952 km^2, up roughly 16% over three decades, and transport demand is expected to continue to rise significantly to 2040 (Federal Council, 2015, ARE, 2016).

While measures such as heavy vehicle charges and road tolls encourage use of Switzerland's high-quality rail system to reduce road demand, fragmentation remains a concern for biodiversity (Sections 1 and 3) and environmental externalities are not yet fully accounted for in transport costs. One study estimated the cost of fragmentation and habitat loss from the Swiss transport system at CHF 1 billion, and biodiversity loss from traffic-related air pollution at nearly CHF 140 million (ARE, 2016).

The biodiversity strategy aims to avoid additional fragmentation by favouring further development of existing transport infrastructure over new construction. It also aims to improve interconnection of habitats and species populations through new or improved wildlife corridors that are incorporated into master plans and zoning plans (FOEN, 2012a). As Section 1 noted, however, wildlife corridors are currently inadequate and require significant investment to improve their functionality.

Recommendations on biodiversity conservation and sustainable use

Status, trends and pressures on biodiversity

- Create a national ecosystem map that identifies priorities for action in terms of protection, pressures and corridors, considering threatened ecosystems and species, as a basis for establishing a more formal and legally binding tool for spatial planning.

Institutional, legal and strategic framework

- Move forward with implementation of the action plan for the Swiss Biodiversity Strategy, pursuing measures with quantified objectives, clear indicators to measure progress and adequate human and financial resources for implementation.
- Work with NGOs, the private sector and education systems to raise biodiversity awareness, engage further with local communities through dialogue on sustainable local development, and develop tools and guidelines for reporting their impact and contributions to biodiversity conservation.

Instruments for biodiversity conservation and sustainable use

- Develop policies, programmes and action plans to meet Switzerland's commitment to protect at least 17% of its territory by 2020, and increase the volume and quality of ecosystem and species protection, by expanding protected areas and other area-based conservation measures to address gaps and improve connectivity within Switzerland and with neighbouring countries; for instance, the Emerald Network should be expanded and co-ordination with Natura 2000 strengthened.
- Increase federal, cantonal and communal funding consistent with the Swiss Biodiversity Strategy and action plan, either through larger public appropriations or by finding alternative sources of revenue, such as economic instruments, which could include taxes on pesticide use and farm nitrogen surpluses and charges for use of ecosystem services; the complete system of agricultural direct payments should be focused so as to holistically optimise biodiversity-related incentives.
- Dedicate resources towards identifying and phasing out subsidies and tax incentives with harmful effects on biodiversity, and redirect tax instruments towards behaviour favouring the conservation and sustainable use of biodiversity, including for landscape management, where incentives within the fiscal system encourage urban sprawl.

Mainstreaming biodiversity into economic sectors

- Pursue efforts to strengthen the potential of the agricultural sector to support biodiversity by selecting biodiversity promotion areas based on environmental objectives (e.g. ecological infrastructure) rather than agricultural objectives.
- Ensure that forestry policy is consistent with biodiversity objectives, and with the national goal of protecting 8% of forest area by 2020 and 10% by 2030; explore opportunities to use economic instruments for forest conservation, such as fees and payments for ecosystem services paid by forest users, while promoting increased private certification.

Recommendations on biodiversity conservation and sustainable use *(cont.)*

- Pursue measures to mitigate the impact of tourism and transport infrastructure on biodiversity, such as improving wildlife corridors, introducing fees for tourism operators and developing biodiversity refuges adjacent to ski resorts.

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