OVERVIEW OF EMISSION REDUCTIONS AND NATIONAL CLIMATE POLICIES IN THE NON-ETS SECTORS ACROSS EUROPE

Study

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

European Climate Initiative EUKI

of the Federal Republic of Germany

Overview of Emission Reductions and National Climate Policies in the Non-ETS Sectors Across Europe

5 December 2018
Sonja Kotin-Förster, Charlotte Cuntz, Yannick Monschauer, Kristen Brand (Navigant)
Walter Kahlenborn, Constanze Haug, Johannes Ackva, Linda Hölscher, Nanne Zwagerman (adelphi)

BMU AZ: IK II 5 – 42206-2/1.5

Project number: 200771

Contact us at BEACON_HelpDesk@navigant.com

Visit us at https://www.euki.de/beacon

The project Bridging European and Local Climate Action is financed by the European Climate Initiative (EUKI). EUKI is a project financing instrument by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). It is the overarching goal of the EUKI to foster climate cooperation within the European Union in order to mitigate greenhouse gas emissions. It does so through strengthening cross-border dialogue and cooperation as well as exchange of knowledge and experience.

The information and views set out in this study are those of the author(s) and do not necessarily reflect the official opinion of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

On behalf of:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

European Climate Initiative EUKI

Abbreviations

BEV	Battery electric vehicles
GDP	Gross domestic product
CAP	Common Agricultural Policy
CCA	Climate Change Agreements
CCS	Carbon Capture and Storage
CCL	Climate Change Levy
CHP	Combined Heat and Power
EBRD	European Bank for Reconstruction and Development
ERDF	European Regional Development Fund
EAFRD	European Agricultural Fund for Rural Development
EPC	Energy Performance Certificates
ESCO	Energy Service Companies
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETS	Emissions trading system
GDP	Gross domestic product
KfW	Kreditanstalt für Wiederaufbau (German government-owned development bank)
LABEEF	Baltic Energy Efficiency Facility
NACE	Statistical Classification of Economic Activities in the European Community (Nomenclature statistique des activités économiques dans la Communauté européenne)
NAPE	National Action Plan for Energy Efficiency
NGiS	New Green in Savings Programm
NZEB	Nearly zero energy buildings
PHEV	Plug-in hybrid vehicle
SlovSEFF	Slovak Sustainable Energy Financing Facility
SME	Small and medium-sized enterprises
UBA	German Federal Environment Agency (Umweltbundesamt)
UNFCCC	United Nations Framework Convention on Climate Change

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Introduction

1.1 Background

Avoiding dangerous changes in our climate has become a core mission for the politics of our time. At the 2015 climate conference in Paris, the global community agreed on a clear minimum target: to keep the average rise in temperature by the end of the century significantly below 2°C compared to pre-industrial levels. In order to achieve the necessary and ambitious climate protection targets, profound structural changes in the economy and society are necessary.

1.1.1 European framework

The EU Member States have pledged to reduce their combined greenhouse gas (GHG) emissions by 20% by 2020 as well as by 40% by 2030 compared to 1990. Over the long term, emissions are to be reduced by 80-95% by 2050. A central instrument for EU-wide emissions reduction is the European Emissions Trading System (ETS). However, more than half of EU-wide GHG emissions, approximately 60%, are generated by sectors outside of the emissions trading system ("non-ETS sectors") (European Commission, 2018). In particular, these emissions originate from the transport, building, and agricultural sectors, with the exception of non-European air traffic and the release of CO_2 emissions and carbon storage via land use, land-use change and forestry (LULUCF) (**Error! Reference source not found.**).

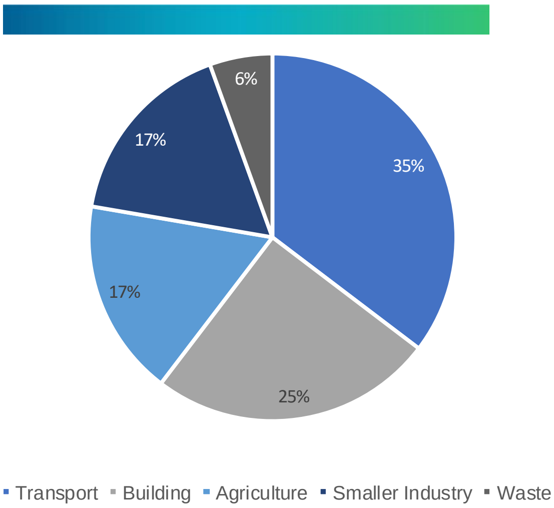

Figure 1: ESD emissions by sector (2015)

By 2020, GHG emissions in non-ETS sectors are to be reduced by 10%, and by 30% on average by the year 2030 compared to 2005. The EU's "Effort Sharing Decision" (ESD) breaks down this target for the period 2013-2020 by dividing it among the individual Member States. In May 2018, the new "Effort Sharing Regulation" (ESR) was adopted for the period 2021-2030. This regulation specifies national reduction targets ranging from zero (for Bulgaria with the lowest gross domestic product (GDP) per capita) to 40% (for Luxembourg and Sweden with the highest GDP per capita) by 2030 compared to 2005. In both periods covered by the ESD and ESR, the Member States have discretion over how much the individual sectors should contribute to the respective targets.

While the 2020 climate targets for non-ETS sectors will be substantially exceeded at EU level, it is apparent that Germany and a number of other countries are unlikely to reach their 2020 targets (Germany: -14% by 2020 compared to 2005). In the period leading up to 2030, Germany will therefore need to undertake additional measures to achieve the Effort Sharing target of -38% compared to 2005, which is significantly more ambitious than the target for 2020.

1.1.2 Germany's next steps

The 2030 target specified in the ESR for Germany for the non-ETS sectors roughly corresponds to the national sector targets for 2030, which are established through the Federal Government's Climate Action Plan. Overall GHG emissions in Germany should be reduced by at least 55% by 2030 compared to 1990. The Climate Action Plan 2050 approved in November 2016 shows a path towards a largely GHG-neutral Germany in 2050 and defines GHG abatement targets for each sector for 2030, while taking into account sector-specific circumstances. In 2018, the German federal government intends to adopt the first programme of measures through 2030 for the Climate Action Plan. It will define specific measures for the achievement of targets in the various sectors.

1.2 Target

This overview paper considers the climate mitigation efforts in the EU Member States, Norway, and Switzerland. The goal is to identify measures across Europe that have already successfully led to GHG emissions reductions in certain countries and non-ETS sectors. Among other things, these measures will be examined in regards to their transferability to Germany. The findings of this paper will serve to support the development of specific measures for implementing the Climate Action Plan in Germany and could also encourage "mutual learning" between Member States in Europe.

1.3 Methodology

This overview paper identifies successful national climate protection instruments in the non-ETS sectors across Europe (transport, buildings, agriculture, waste, industry). Climate protection efforts in all 28 Member States, Norway, and Switzerland will be considered.

The overview paper is subdivided into the following work steps:

Step 1 – Data analysis on GHG emissions reductions and ESD target achievement per country (chapter 2)**.** Firstly, the ESD targets and expected target achievement for all 28 EU Member States as well as comparable targets and the status quo in Norway and Switzerland will be examined. During this process, countries that are particularly successful across all sectors will be identified. In addition, the influence of the economic crisis on emissions trends will be presented.

Step 2 – Overview of sector-specific developments (respective sub-chapter x.2.1 in the chapters 4-8). In addition, sector-specific emissions data will be analysed to identify countries that are particularly successful in certain sectors even though they may only average modest emissions savings overall. Sector-specific emissions data from 2005-2015 will be compared.

Step 3 – Selection of country-sector combinations (respective sub-chapter x.2.2 in the chapters 4-8). Based on the findings of the previous analysis, the project team compiles an overview of countries with successful emissions reductions for each sector and supplies initial explanations for the reductions achieved.

Step 4 – Sector-specific detailed examination of successful instruments in the selected countries (respective sub-chapter x.2.3 in the chapters 4-8). The selected country-sector combinations from the previous step will then be examined in greater detail in order to enable an assessment of their transferability to Germany.

2 Overview of reduction effects from all countries

2.1 ESD target achievement

With regard to 2015, the ESD emission budgets were exceeded by all Member States with the exception of Malta (**Error! Reference source not found.**). By 2020, 21 of the EU-28 are expected to fulfil or exceed the 2020 ESD targets. EU-wide, it is estimated that the targets will be exceeded by an average of 7%.[1]

Light green: fulfilment or over fulfilment by up to 10%; green: over fulfilment of 10% or more; orange: over fulfilment with under-average economic growth; red: under fulfilment.[2]

Table 1: Overview of ESD target achievement

Country	2015 ESD target	2020 ESD target	ESR target 2030	Target achievement status in 2015	Target achievement projection for 2020
	($MtCO_2e$)	($MtCO_2e$)	($MtCO_2e$)	(Over/under fulfilment in %)	(Over/under fulfilment in %)
Belgium (BE)	75.3	68.2	52.2	3%	-4%
Bulgaria (BG)	27.5	26.5	22.1	8%	18%
Denmark (DK)	35.0	32.1	24.5	7%	3%
Germany (DE)	459.1	410.9	296.2	3%	-4%
Estonia (EE)	6.3	6.0	4.7	3%	0%
Finland (FI)	30.8	28.5	20.7	3%	-1%
France (FR)	384.4	342.5	250.9	8%	7%
Greece (GR)	59.6	60.0	52.6	24%	19%
Ireland (IE)	44.6	37.7	33.0	4%	-21%

[1] Author's own calculations based on data from the European Environment Agency (EEA, 2017)

[2] Based on data from the European Environment Agency (EEA, 2017) and the European Commission (European Commission, 2017). Germany's expected target shortfall in the year 2020 is greater according to current estimates, as the total gap (ESD and ETS sectors) is 8% (BMU, 2018).

Country	2015 ESD target	2020 ESD target	ESR target 2030	Target achievement status in 2015	Target achievement projection for 2020
Italy (IT)	304.2	291.0	224.1	10%	10%
Croatia (HR)	20.0	19.3	16.2	22%	21%
Latvia (LV)	9.4	10.0	8.0	4%	8%
Lithuania (LT)	13.7	15.2	12.1	3%	11%
Luxembourg (LU)	9.1	8.1	6.1	6%	-4%
Malta (MT)	1.2	1.2	0.9	-8%	-8%
Netherlands (NL)	118.4	107.4	81.8	15%	12%
Austria (AT)	51.5	47.8	36.4	4%	-3%
Poland (PL)	196.1	205.2	167.4	5%	7%
Portugal (PT)	49.9	49.1	40.3	18%	18%
Romania (RO)	79.3	89.8	74.0	6%	15%
Sweden (SE)	40.4	36.1	26.1	16%	18%
Slovakia (SK)	24.7	25.9	20.2	19%	22%
Slovenia (SI)	12.4	12.3	10.0	14%	13%
Spain (ES)	223.7	212.4	174.6	12%	11%
Czech Republic (CZ)	64.0	67.2	53.1	4%	8%
Hungary (HU)	52.6	52.8	44.6	21%	26%
United Kingdom (UK)	349.7	350.9	263.2	7%	12%
Cyprus (CY)	5.9	4.0	3.2	32%	10%
EU-28	**2,749.0**	**2,618.2**	**2,019.1**	**8%**	**7%**

In particular, central and eastern European Member States such as Hungary, Slovakia, and Croatia were able to significantly exceed their 2020 targets. However, it should be considered that some of these targets allow for significant increases in emissions compared to 2005 in order to adequately take into account the different economic circumstances of the Member States. The following 13 countries may increase their emissions up to 2020 compared to the emissions levels in 2005 (**Error! Reference source not found.**). Due to these different circumstances, these countries are only partially suitable for comparison. However, some countries have made significant improvements in emissions developments and emission intensities, which have been included in the analysis.

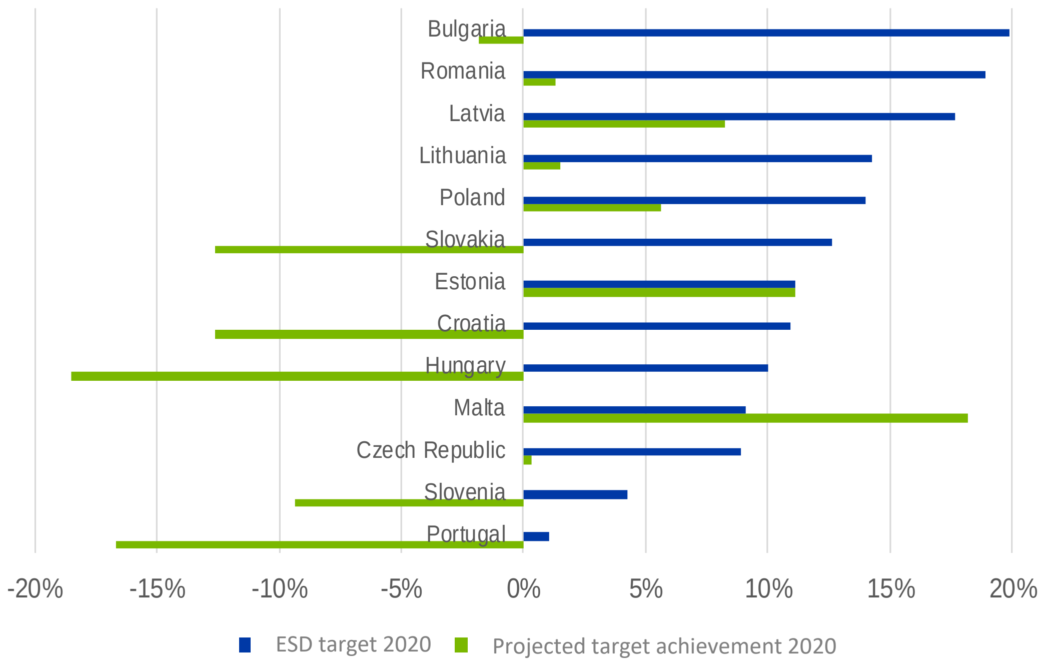

Figure 2: ESD growth targets for 2020 and projected target achievement 2020 (compared to 2005 for all cases)

Norway and **Switzerland** are not considered in regards to ESD target achievement in 2020 because they do not have ESD targets for the year 2020. They are, however, considered in the analysis of structural and sector-specific developments. By the year 2030, emissions in non-ETS sectors in Norway are to be reduced by 40% compared to 2005 according to proposals from the European Commission (Norwegian Government, 2017). This would mean that Norway, together with Sweden and Luxembourg, have the most ambitious ESD targets for the year 2030.

2.2 Influence of the economic crisis on emissions trends

All over Europe, the 2008/2009 financial and economic crisis had a long-term impact on emissions trends, whereby the extent of the effects varied among the Member States and lasted for different periods of time. Germany was less affected by the economic crisis than the other EU countries and was therefore able to overcome it quicker than most of the other Member States. Unlike Ireland, Greece, Spain, Portugal, Italy, and Cyprus, Germany was also not affected by the subsequent Euro crisis.

Error! Reference source not found. summarises economic development in Europe over the period 2005–2015 based on the data for gross domestic product (GDP), GDP per capita, and the aggregated per capita consumption of the country; all figures have been adjusted for inflation. The data on consumption expenditure were also included because the economic statistics alone based on GDP exhibited a great degree of distortion for a number of smaller Member States, above all for Ireland. This results from the transfer of company turnover and profits, which are not related to productive activities in the country, for example due to shell companies. The consumption expenditure trends in Ireland, which differs substantially from the trends in GDP data, clearly show this difference. In other Member States with smaller differences, such a deviation may also be caused by other aspects, in particular to a change in the savings rate of private households or due to national debt instead of the transfer of company turnover and profits. A detailed examination of the added value in the individual sectors reveals that economic development is not uniform — generally speaking, economic development in the crisis countries is slightly better in the agricultural than in the industrial sector.

In order to choose countries in which emissions savings can be attributed to policy measures and not to economic downturns, it is important to consider economic development. In part, this is done by also considering intensities in the following tables; i.e. the relationship between the added value achieved in the respective sector and the related, resulting emissions. However, these intensities do not always pertain to economic development. Hence, in the case of GDP-related intensities, possible effects of structural change must also be included in the analysis for crisis countries. This requires an examination of the developments in the various sub-sectors. Hence, a comparison with these countries is generally not advised, although individual cases may form an exception.

Table 2: Overview of structural data.

Red: negative development of economic indicators; green: the five which exhibited the most development in their economic indicators

Structural data[3]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Key indicators																															
GDP	10%	13%	28%	23%	7%	15%	17%	47%	-9%	4%	9%	2%	-4%	4%	16%	28%	30%	9%	43%	11%	13%	46%	-1%	31%	11%	43%	4%	20%	13%	14%	21%
GDP per capita	7%	5%	38%	19%	2%	15%	21%	32%	-8%	-2%	3%	4%	-9%	-10%	32%	45%	6%	11%	30%	7%	7%	45%	0%	40%	8%	42%	0%	11%	4%	2%	9%
Per capita consumption	6%	5%	35%	11%	4%	11%	25%	-1%	-5%	-3%	6%	4%	-7%	-2%	33%	36%	2%	3%	13%	4%	5%	36%	0%	44%	6%	25%	8%	11%	2%	16%	6%

The cells marked in red each indicate negative economic development over the overall period 2005-15; i.e. that the economic performance in these countries in the year 2015 was still below that of 2005. Differences between the three core indicators are due in part to certain distortions and in part to normal economic developments (see above). The demographic trends in the EU Member States, Norway, and Switzerland, which differ to a certain degree, also play a role. In a number of countries, the population has grown significantly, while in others it declined.

[3] All data, unless indicated otherwise: comparisons 2005-2015 (also in subsequent tables). Source: Eurostat. GDP: GDP per capita and per capita consumption: [nama_10_pc]. GDP: [nama_10_gdp]. 2010 served as the base year for inflation adjustment in all cases.

2.3 Reduction effects in ESD and ETS sectors

The European ESD sectors interact in a variety of ways with the sectors under the European Emissions Trading System (EU ETS) as well as with comparable sectors in the rest of the world. Hence, emissions reductions observed in one ESD sector can always be due to multiple reasons, which need to be distinguished if the overall effect of policies is to be assessed. Schematically, these reasons can be subdivided into four mechanisms, which are visualised in **Error! Reference source not found.**.

The simplest — and from a climate policy standpoint desirable — cases are measures that lead to direct emissions reductions in the ESD sector, e.g. the substitution of fossil fuels with renewable energies (1). Via instruments that lead to stronger sectoral coupling, e.g. the promotion of electromobility, or other mechanisms that shift emissions from ESD sectors into the ETS, e.g. incentives for more intensive use of district heating, emissions in ESD sectors are reduced, but — depending on the underlying energy mix — potentially increase in ETS sectors (2). Conversely, activities that take place in the ESD sector and which potentially release emissions there, e.g. the production of biogas, thereby result in fossil emissions being saved (3) in the ETS sectors. In these cases, the climate policy evaluation depends on a large number of assumptions about the EU ETS and the developments of electricity demand and production. These include, for example, the political robustness of the ETS CAP when significant emission quantities were to, for example, fall under the ETS due to successful electromobility strategies (where they then lead to a rapid price increase as a result of increased scarcity). For example, the question of to what extent the newly introduced market stability reserve (MSR) is able to effectively exploit resulting excesses, and if so, whether by doing so it changes the emission effect by shifting activities (mechanism 2) or avoidance (mechanism 3) to the ETS, is also significant. Finally, the shifting of activities in the ESD sector, e.g. the production of small industrial plants to non-European countries or the import of biomass can reduce ESD emissions in the EU, while increasing non-European emissions. However, this effect is comparatively small (4).

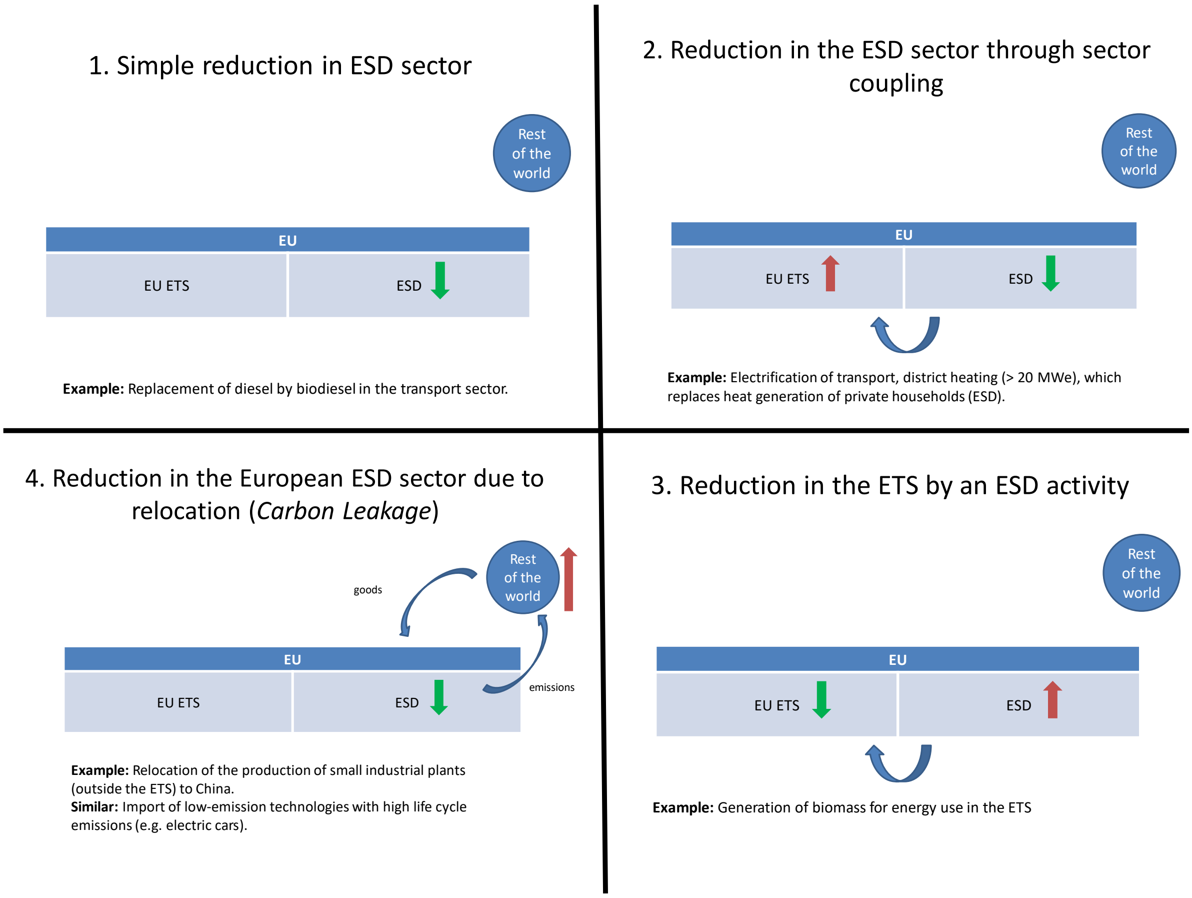

Figure 3: Reduction effects in ESD and ETS sectors

3 Climate protection law as a legal-institutional framework for national climate policy

3.1 Background

In addition to sectoral policy instruments, climate protection laws are primarily regarded as legal-institutional, cross-sectoral approaches to national climate policy. Several EU Member States including the UK, France, Sweden and Denmark, have adopted climate change legislation, setting the framework for their national climate policy. Some of these laws have already been in force for several years, such as the Climate Change Act in the UK, while others have been adopted in recent years and are shaped in part by the British model, as in Sweden. One commonality of the climate protection laws examined here is the adoption of a long-term target framework, often in conjunction with the institutionalisation of reporting obligations by the government and an advisory panel of experts for regular evaluation. The objective is to create a long-term, stable regulatory framework in which climate protection is anchored.

On the other hand, the actual makeup of the individual climate protection laws is quite different, ranging from the institutionalisation of a governance framework to the adoption of detailed strategies and measures to decarbonise the entire economy. The same applies to the anchoring of the reduction targets. Here, some refer to a separate parliamentary decision, while other climate protection laws contain quantified targets and translate them into greenhouse gas budgets and even contain concrete specifications for the development of the energy mix.

The following section describes the climate protection laws of the United Kingdom, France and Sweden in more detail.

3.2 Selected instruments

3.2.1 United Kingdom: Climate Change Act

Brief description	The British Climate Change Act (CCA) was drafted in 2008 as a comprehensive framework for climate change and includes relevant institutions, processes and control mechanisms. The main functions of the law are a GHG emission reduction of 80% by 2050 (compared to 1990), legally binding carbon budgets (every five years), the establishment of an independent advisory body (Climate Change Committee) and planning and reporting obligations (CCA, paragraph 1).
The concept	The CCA is an environmental law that sets strict emission targets. It does not define how to achieve these objectives. The 80% long-term emission reduction target is broken down into carbon budgets, which are recommended by the Climate Change Committee every five years and adopted by Parliament (CCA, paragraph 1). In order to limit emissions to the level set by these budgets, the government proposes to the Parliament specific guidelines and action plans that divide the national reduction target into individual economic sectors. These are then passed by Parliament. Government transparency and accountability are reinforced by regular planning and reporting obligations (Client Earth, 2016).

Effects	The United Kingdom has been able to achieve a significant reduction in GHG emissions since the adoption of the CCA and to this day has fulfilled all priority commitments. The first two carbon budgets set to meet the 2050 target have been met, One of the greatest achievements of the CCA is the fact that it has successfully and continuously anchored the discourse of climate change in the institutional and political landscape (Lockwood, 2013). One of the most significant aspects of the CCA is the Committee on Climate Change established by this law, which is considered to be an institutional success and whose work as an independent body has made a significant contribution to the successful implementation of the CCA.
Transferability to Germany	Due to the institutional influence on the national climate policy, tranferring the CCA to Germany would be advantageous as a model of a climate framework law. Legal and political security could be granted by embedding the German reduction targets in a similar construct, especially if it contains clear legal provisions in the event of non-compliance with the legal requirements.

3.2.2 France: Energy Transition for Green Growth Act

Brief description	The French Energy Transition for Green Growht Act (LTECV) was adopted in 2015 and builds on previous climate and energy legislation in France. It contains a comprehensive list of goals and measures that go beyond a purely climate-related law. The LTECV is a comprehensive legal document that not only deals with climate change but also contains detailed strategies for low-carbon economic development and measures in energy, transport, and economic and construction policies.
The concept	The LTECV goes far beyond the definition of greenhouse gas emission limits or emission reduction pathways and includes a number of legally binding quantitative targets for the French economy. Many of these goals are divided among the different economic sectors. The LTECV's climate policy goals are to reduce GHG emissions by 40% by 2030 and 75% by 2050 (compared to 1990 levels). In addition to specific targets for the energy sector, the LTECV also sets out detailed action plans and proposals, such as for how these emission reductions and energy transition should be achieved. The system of carbon budgets enshrined in the framework legislation of the LTECV also sets maximum emission limits, which cannot be exceeded in a certain period of time. Monitoring reports and evaluations are the responsibility of the government (Grantham Research Institute on Climate Change and the Environment, 2015). However, the implementation of the energy transition is not limited to national actors, but also includes local actors.
Effects	Since the LTECV came into force only relatively recently, it is difficult to reliably predict its impact on emission reductions. However, implementation has so far been driven by a number of action plans and government decisions. Progress has been made in the development of the renewable energy sector and the electrification of the transport sector (Council of Ministers, 2017). The effectiveness of the LTECV will only become fully apparent once it has gone through the first evaluation cycle.
Transferability to Germany	The LTECV is a highly complex piece of legislation and therefore not recommended for Germany. In addition, a major difference between France and Germany is the composition of the energy sector, which is why emission reductions in this sector require different measures in both countries. The LTECV was, however, developed with extensive

	participation and contributions from the various stakeholders and could therefore be an interesting model for the emergence of the German Climate Action Plan 2050.

3.2.3 Sweden: Climate Act

Brief description	The Swedish Climate Act (Klimatlag) was adopted in 2017 by a large majority as part of the climate policy framework and came into force in 2018. The Climate Protection Act institutionalises a governance framework to ensure the achievement of Sweden's long-term emission reduction targets. The latter were strengthened separately as part of the framework and provide for Sweden to be carbon neutral by 2045. As a further pillar of the framework, an independent expert council has been established with the mandate to periodically review government policy regarding its compatibility with climate objectives.
The concept	The Climate Act commits the government to the long-term emission reductions necessary for climate protection. For the quantification and concrete time intervals of the reduction targets, the law refers to a separate parliamentary resolution, currently the targeted climate neutrality by 2045, which is part of the climate policy framework. At its core, the Climate Act sets the procedural framework for national climate policy and institutionalises government accountability. For example, in the course of the national budgetary procedure, the government is required to present a climate report every year, outlining emission trends, adopted climate measures and, in addition, necessary measures and a corresponding timetable. In addition, every four years the government is required to submit an action plan in which, among other things, the impact of existing measures on long-term climate objectives is analysed. Similarly, the climate impact of adopted and planned measures in the different areas of budget expenditure should be laid out, in particular with regard to compliance with national and international climate commitments.
Effects	It is difficult to make reliable statements about the effect of the Climate Act at this time since the law has only been in force since 2018. The link with the budgetary procedure should make climate policy objectives more visible in other policies. In conjunction with Sweden's ambitious climate targets, the Climate Act should help create a reliable regulatory framework for investors and civil society in the longer term and increase confidence in achieving the climate goals.
Transferability to Germany	The essential elements of the Swedish Climate Protection Act seem fundamentally well suited in terms of transferability to the German context. Greater institutionalisation of German climate governance, for example through increased accountability and reporting obligations, could make a significant contribution to increasing the reliability and credibility of national goals. The direct linking of the annual climate report to the adoption of the budget would be constitutionally problematic in Germany, but a separate assessment of the compatibility of the budget with the long-term climate goals is possible.

4 Detailed assessment of the transport sector

4.1 Description of the transport sector

In all European countries to be considered except Ireland, Poland, Romanian, and the Netherlands, the transport sector is the non-ETS sector with the greatest GHG emissions. EU-wide, transport is responsible for over one third of ESD emissions. 97% of the sector's emissions come from road traffic; the rest is generated by inland water transport, diesel locomotives in rail, and other transport systems (e.g. pipelines) (**Error! Reference source not found.**). Air traffic, the electricity consumption of electrified rail traffic and international maritime traffic are not taken into account by the ESD.

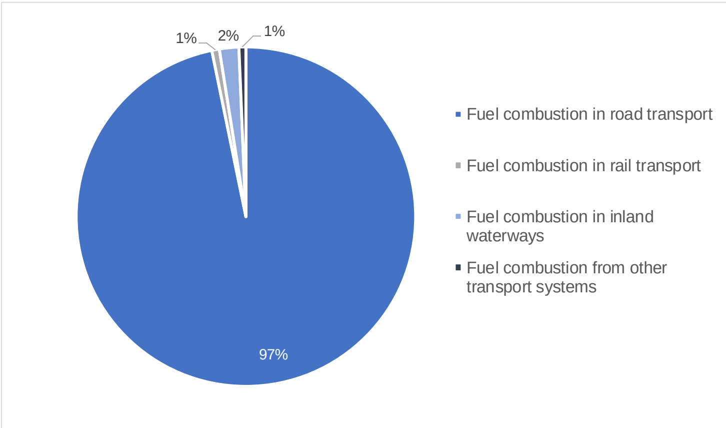

Figure 4: Emissions in the transport sector by source sector (2015)

The transport sector is dependent on combustion engines and hence primarily fossil fuels. The percentage of renewable energy in the sector, above all in the form of biofuels, has been low to date (EU-wide in 2015: 6.7%). By 2020, this percentage is to increase to 10% according to the Renewable Energy Directive. Electromobility is comprehensively promoted in numerous Member States, but the percentage of electric vehicles in the total vehicle stock was 0.3% on average, and in half of the Member States still below 0.1% in the year 2017 (Ecofys, 2017). In addition, significant reductions in emissions can be achieved by shifting road transport to other modes of transport, such as local public transport and long-distance commercial and passenger rail transport. In the past 10 years, hardly any changes have been made to the model shift in both passenger rail and freight transport.[4]

[4] https://ec.europa.eu/eurostat/statistics-explained/index.php/Freight_transport_statistics_-_modal_split;https://ec.europa.eu/eurostat/web/products-datasets/product?code=T2020_RK310

4.2 Sector-specific developments

4.2.1 Overview of sector-specific developments

EU-wide, the emissions of the transport sector have fallen by approximately 6% between 2005 and 2015, although there was an increase in emissions up to 2007 (and particularly in the 1990s). Since 2013, emissions have also increased, as improvements in fuel efficiency have not been able to compensate for the effects of the growing demand for transport. In Germany, on the other hand, a decline was observed until 2009, but even increased in subsequent years due to the aforementioned reasons.

Apart from the absolute emissions trends, there are three different emission intensity values in the transport sector that are especially useful when selecting particularly successful countries and conducting further analysis on them. For one, the **emission intensity of the transport sector (I.NACE.V$_{8\text{-}15}$)** is of relevance although it does not include private automobile traffic.[5] The intensity reflects the relationship between the emissions from this sector and its added value, which means it can highlight trends towards a more climate-friendly economy. In addition, the **emissions per passenger kilometre in passenger cars (I.PKW pkm)** are also considered. These offer an approximation of the emissions intensity of private automobile traffic, and in particular make it possible to recognise changes in the consumption efficiency of vehicles.[6] The third indicator is the **intensity of energy consumption in transport**, which represents the emissions intensity of the energy used in the sector.

[5] The NACE sector transport (H49) encompasses all transport products and services by companies, i.e. not only the transport of goods, but also the transport of persons by companies of all types (public transport, taxi services, rail etc.). Water and air transport are excluded from H49, but transport via pipelines is included. A more detailed record of certain types of transport companies is currently not available in the statistics.

[6] The database for the emissions according to the common reporting format (IPCC 2006) is calculated based on fuel sales measured (in this case categorised according to fuel type, biofuel percentage etc.) according to standard emissions factors. This form of calculation is highly accurate (significantly more accurate than aggregated laboratory or measurement data on emissions), but results in a certain amount of distortion in transit countries. This indicator can only be seen as an approximation, as the data on passenger kilometres used for comparison are not entirely mutually comparable and do not have exactly the same reference value as fuel sales (in most countries the total kilometres of all persons transported with passenger cars domestically).

Table 3: Emissions trends and intensities in the transport sector (2005-2015).

Green: emissions and intensity trends in the selected countries; **bold**: the five countries with the greatest reductions in absolute emissions as well as the relevant intensities.

Transport[7]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Absolute emissions trends																															
Emissions	-6%	0%	20%	4%	-7%	0%	8%	-9%	**-22%**	**-18%**	-6%	7%	**-17%**	-10%	1%	22%	**-20%**	2%	15%	-12%	-9%	32%	**-18%**	26%	21%	-12%	-13%	-13%	-7%	2%	-3%
Relevant emissions intensities																															
Intensity of transport sector (*I.NACE.V$_{8-15}$*)	-8%	**-46%**	25%	37%	19%	9%	84%	-10%	9%	**-25%**	-21%	15%	8%	**-45%**	-3%	18%	**-56%**	-8%	N/A	-10%	6%	-8%	27%	3%	-11%	**-60%**	-17%	-19%	-7%	23%	N/A
Intensity per passenger kilometre (*I.PKW pkm*)	-9%	-2%	-4%	6%	-10%	-13%	2%	-15%	**-40%**	2%	-7%	2%	-11%	-30%	-7%	60%	**-32%**	-15%	-6%	-6%	**-25%**	6%	-16%	-13%	-5%	13%	-18%	-17%	-9%	-15%	-28%
Intensity of energy consumption in transport	-3%	-3%	1%	-3%	2%	-1%	3%	2%	-2%	1%	-4%	-1%	-5%	-2%	-2%	-4%	-4%	-2%	-3%	-4%	**-9%**	-3%	**-5%**	-2%	0%	-5%	**-13%**	-13%	-1%	-7%	N/A

[7] All data, unless otherwise indicated: comparisons 2005-2015 (also in subsequent tables). Emissions: Eurostat [env_air_gge], according to source area, (source: EEA), CRF1A3 overall, minus 1A3A. I.NACE.V: intensity of the transport sector on land, [env_ac_aeint_r2] for the NACE sector H49. I.PKW pkm: calculation of emissions per passenger kilometre in passenger cars based on DG MOVE statistical pocketbook and CRF1A3Ba (inconsistencies in the data for Lithuania). Intensity of energy consumption in transport: comparison of emissions with the full energy footprints [nrg_110a].

The **absolute emissions** show very different trends in the transport sectors of the various Member States (**Error! Reference source not found.**). In Greece (-22%) and Luxembourg (-20%), but also in other eastern and south European countries, as well as a number of Scandinavian countries, the emissions have dropped dramatically between 2005 and 2015. In Germany and Belgium, on the other hand, transport emissions in the ESD segment have remained stable despite clear reduction goals, while they have increased significantly in countries such as Romania (+26%) and Poland (+32%). Even greater discrepancies were observed in the trends for **emissions intensities**. While the intensity of the transport sector in Slovakia decreased by 60% (the greatest reduction in Europe), it increased by 37% in the neighbouring Czech Republic (the second-highest increase).[8] The emissions intensity of passenger kilometres was reduced in all countries with the exception six Member States (Estonia, Croatia, Lithuania, Poland, Slovakia, and Spain). With 40%, Greece exhibited the greatest decrease in intensity. The intensity of energy consumption in transport only increased slightly in Bulgaria, Denmark, and Estonia, and remained unchanged in Slovenia. In all other countries examined, the intensity fell slightly — by up to -13% in Finland and Sweden, the countries with the best results.

At this point, it should be noted that the reductions in emissions and/or intensities achieved in various countries are only indicative to a limited extent due to the economic crisis or other distortions (see **Error! Reference source not found.**). This was taken into account when selecting the countries to be further analysed.

4.2.2 Selection of country-sector combinations

Based on the emissions trends in the sector and other unique sector-specific aspects in the form of e.g. interesting policy instruments and successes as well as their relevance for Germany and other EU Member States, the following countries were chosen: **France, the Netherlands, Switzerland, Sweden, Norway**, and the **UK**. These are described in detail in **Error! Reference source not found.**.

Table 4: Country-sector combinations considered for the transport sector

Country	Unique aspects
France	• **High reduction in emissions intensity** (NACE and passenger cars). • Breakdown according to mode of transport in goods traffic comparable to Germany, but France was able to reduce its **emission intensity in lorry traffic** in particular (Ecofys et al., 2017)**.** • At 0.4%, the percentage of electric vehicles in the entire vehicle population is slightly higher than in Germany (0.3%). Furthermore, the ratio of charging stations to electric vehicles is higher in France than in Germany (Ecofys, 2017).
Netherlands	• Moderate reduction in emissions intensity (NACE) which can be attributed to both a shift in transport as well as a **leading role in the promotion of electromobility**: By 2020, 10% of new vehicles sold are to be electric vehicles, and this percentage is to be increased to 50% by 2025. • The percentage of electric vehicles in the Netherlands' entire vehicle population is almost five times that of Germany (Ecofys, 2017). • At 1 to 3.6, the ratio of electric vehicles to charging stations in the Netherlands is the highest in Europe (Ecofys, 2017).

[8] In particular, the significant reduction in emissions intensity in Slovakia is attributable to the decrease in gas deliveries from Russia via Ukraine, whereby significantly less fuel is required for the transit of gas in Slovakia (between Ukraine and the Baumgarten hub in Austria).

Country	Unique aspects
Norway	• **High reduction in emissions intensity** (passenger cars), but a slight increase in absolute emissions which may be attributable to an increase in emissions in lorry traffic. • Norway is the **global leader where e-mobility is concerned** and has a 21% market share for battery-driven electric vehicles as well as an electric vehicle percentage of 7.7% in its vehicle population (Ecofys, 2017).
Sweden	• **High reduction in emissions intensity** (NACE and passenger cars). • Sweden aims to achieve a **CO_2-free vehicle population by the year 2030** and hence has a significantly more ambitious target than Germany. • At 1.0%, the percentage of electric vehicles in Sweden's entire vehicle stock is three times as high as in Germany (0.3%). The ratio of charging stations to electric vehicles in Sweden is comparable to the situation in Germany (Ecofys, 2017). • The high CO_2 tax in Sweden (chapter 5.3.6) also has an impact on the transport sector.
Switzerland	• **High reduction in emissions intensity** (passenger cars). • The transport sector generates the most GHG emissions in Switzerland, i.e. more than the energy or industrial sector for example (BAFU, 2017). • Switzerland is a transit country, but the number of lorry trips per year has decreased significantly since 2001, by almost a third (UVEK, 2017). • **71% of its rail transport consists of transalpine goods transport.**
UK	• A national emissions budget ("Carbon Budget") **specifies sector-specific emissions reduction targets**. • The UK has more electric vehicles than Germany. The percentage of electric vehicles in the overall vehicle stock is similar in both countries, but there are significantly more charging stations in the UK than in Germany (Ecofys, 2017).

The following countries were not chosen because even though some of them achieved emissions and/or intensity reductions, these reductions were either primarily due to the economic crisis or other distortions are at play.

Table 5: Countries not chosen in the transport sector despite some having achieved emissions and/or intensity reductions

Country	Unique aspects
Belgium	• High reduction in emissions intensity but only a **small decrease in emissions intensity for passenger car transport**.
Finland	• High percentage of **biofuels like in Sweden**. • No leading role in the electromobility sector: **Percentage of electric vehicles below EU average.**

Country	Unique aspects
Greece	• Reduction in emissions due primarily to the **economic crisis**.
Italy	• Reduction in emissions due primarily to the **economic crisis**.
Luxembourg	• Due to its geographical location and low excise duties, Luxembourg is an attractive transit country for freight transport and therefore has distorted statistics in this regard. • Diesel accounts for 80% of annual fuel consumption, with 75% thereof can be attributed to vehicles not registered in Luxembourg.
Austria	• As a **transit country**, Austria's statistics are distorted, and exhibited no reduction in emissions for lorry traffic. • Emissions for heavy traffic have doubled since 1990.
Portugal	• Reduction in emissions due primarily to the **economic crisis**.
Romania	• **Large increase in overall emissions**. Difficult to compare with Germany.
Slovakia	• No leading role in the electromobility sector: **Low percentage of electric vehicles** (2017: >1%). • Reduced intensity in transport sector entirely attributable to changes in the gas market (pipelines).
Spain	• Increased emissions in passenger car traffic. It is possible that the reduction in emissions was triggered by a shift in transport. However, a large percentage of the reduction in emissions is due to the **economic crisis**.
Cyprus	• Reduction in emissions is primarily due to the **economic crisis**. The statistics for Cyprus are not reliable.

4.3 Selected instruments in the transport sector

For the transport sector, key policy instruments were identified that are of particular relevance with regard to Germany for the countries with above-average sector-specific emissions trends listed in **Error! Reference source not found.**. The Swedish CO_2 also had a decisive impact on Swedish transport emissions. As a cross-sector instrument, it is introduced in section 5.3.6 and the influence on the transport sector discussed in the corresponding fact sheet.

4.3.1 France: Bonus-malus system for vehicles[9]

Brief description	Since 2008, this instrument has provided direct financial incentives for vehicle buyers to choose vehicles that are less CO2 intensive and has already achieved significant success (see effects). As of 2018, the standards were tightened even further.
The concept	Buyers of new vehicles with low CO2 emissions receive a bonus, while buyers of new vehicles with high CO2 emissions need to pay a penalty. The amount of the payments depends on the CO2 emissions of the vehicle. Bonus payments are only made for electric and hybrid vehicles. In the case of particularly efficient vehicles, up to 27% of the purchase price (max. EUR 6,000) may be reimbursed via the bonus. Buyers of a car with high emissions need to pay a staggered penalty beginning at 120 gCO2/km which starts at EUR 50 and may amount to more than EUR 10,500 for emissions exceeding 185 g/km. Furthermore, owners of a used vehicle with high CO2 emissions must pay a special annual fee.
Effects	Since the introduction of the bonus-malus system, the market share of more efficient vehicles has increased significantly. For example, sales of vehicles eligible for bonuses increased by 75% between 2011 and 2012, while vehicles that incurred a penalty experienced a -28% decrease in sales. The average emissions of new vehicles decreased to 127 gCO2/km in 2011 (2007: 149.3 gCO2/km). Furthermore, more vehicles were purchased from French manufacturers as they offer a large number of low-emissions models.
Transferability to Germany	In principle this instrument is applicable to Germany. The fact that similarly structured instruments are well-received by consumers in Germany is shown in the environmental subsidy ("scrapping incentive") from the year 2009. With regard to the GHG emissions reductions achievable via the instrument, it should be taken into account that electric vehicles in Germany exhibit a significantly higher indirect CO2 intensity due to its significantly more emissions-intensive electricity mix than that of France.

4.3.2 Netherlands: Tax rebates for electric vehicles[10]

The Netherlands is a trailblazer when it comes to electromobility, to which the tax rebates for electric vehicles have greatly contributed.

Brief description	Since 2006, tax rebates have been issued for electric vehicles in the Netherlands. Since 2015, there has been increased emphasis on promoting battery electric vehicles (BEV). By 2030, all newly registered vehicles in the Netherlands are to be emissions-free.
The concept	Electric vehicles are exempt from the VAT and motor vehicle taxes in the Netherlands and plug-in hybrids (PHEV) receive a 50% tax rebate. The taxation of non-cash benefits for the private use of company (passenger) cars is 4% instead of 22% for owners of electric cars.

[9] Sources: French Embassy in Germany, 2017; ADEME, 2009; IEA, 2015; Ministry for the Economy, Industry and Employment

[10] Sources: EVBOX, 2017; RAI Vereniging; RVO, 2016; IEA, 2013

Effects	The tax rebates constitute a key incentive for end customers to purchase electric vehicles. At 1.38% (2016) of the entire vehicle stock, the Netherlands has one of the highest percentages of electric vehicles in its overall vehicle population in Europe. Until the end of 2016, BEVs and PHEVs received similar tax rebates. However, consumer preferences were shaped less by the differences between incentives for PHEVs and BEVs, but instead the higher flexibility and lower acquisition costs for PHEVs compared to BEVs, thereby resulting in higher market acceptance for PHEVs.
Transferability to Germany	In Germany as well, the instrument of tax rebates for electric vehicles has already been implemented, albeit to a lesser extent than in the Netherlands. For example, electric cars are exempt from motor vehicle tax for a period of ten years as part of the "Governmental Programme for Electromobility". This applies to passenger cars, utility vehicles, and quadricycles that have a purely electrical drive or emit less than 50g/km regardless of technology (only for passenger cars and utility vehicles). For the taxation of company vehicles, electric vehicles are currently still at a disadvantage, but the existing competitive tax disadvantages are to be rectified. The example set by the Netherlands could serve as a starting point for expanding tax rebates.

4.3.3 Norway: Incentives for electric vehicles[11]

Norway's above-average successes in the transport transition can be attributed to a combination of various measures.

Brief description	Norway is a global leader when it comes to electromobility and has promoted e-mobility since the 1990s with corresponding incentives. These includes both financial and non-financial advantages for the consumers of electric vehicles. By 2025, only emission-free vehicles are to be sold in Norway.
The concept	Since 1997, electric vehicles in Norway have been exempt from toll fees, since 1999 from urban parking fees, and since 2009 for the use of ferries, which are of great importance for transport within Norway. Since 2005, electric vehicles can also use bus lanes in urban traffic (however, in Oslo this only applies if at least two persons (including the driver) are in the vehicle).
Effects	Due to these and other promotional measures, Norway has the highest percentage of electric vehicles in its vehicle stock (2016: 7%) as well as in the registration of new vehicles (2017: 39.2%, incl. plug-in hybrids).
Transferability to Germany	Transferability to Germany currently does not apply when it comes to the exemption of toll fees, but tolls for passenger cars are expected to be introduced in the current legislative period. Furthermore, unlike Norway, car ferries play a marginal role in domestic travel in Germany. However, combined incentives for electromobility can be transferred to Germany. Alternatively, other privileges could be introduced. For example, the German Electromobility Act (EmoG) already specifies that electric cars may be exempted from parking fees.

[11] Sources: Norwegian Ministry of Climate and Environment, 2017; Norsk Ebil Forening, 2018

4.3.4 Sweden: Regulations for company vehicles[12]

Due to the high percentage of service vehicles and company cars in Sweden's vehicle stock, the country's regulations on service vehicles has been able to contribute to reducing fuel consumption and emissions in the country. Furthermore, the cross-sector CO_2 tax is also responsible for the reduction in emissions (see chapter 5.3.6).

Brief description	A large number of new vehicles in Sweden are service vehicles or company cars that employers generally also entrust to their employees for private use. These company cars are frequently larger and consume more fuel than the rest of the vehicle stock. In order to counteract this trend, various regulations were introduced in Sweden (and are continuously modified).
The concept	First, it was stipulated that employees must bear the fuel costs for their private trips on their own, so that there is an incentive to adopt a more efficient driving style and for using fuel-saving vehicles. As early as 2001, laws were passed stating that the taxable non-cash benefits arising from the private use of company cars would be reduced for lower-emission cars running on biofuels. Hence, the percentage of non-cash benefits that need to be taxed for vehicles running on ethanol (E85), natural gas, or biogas is 20% lower than for vehicles running on conventional fuels. The taxable non-cash benefits for hybrid and electric cars are 60% and 80% lower respectively when compared to more emissions-intensive vehicles. Since 2012, it has been possible to completely offset plug-in hybrid and biogas vehicles from one's taxes. Furthermore, there are additional stipulations in place for company vehicles in the public sector. All normal purchased or leased vehicles as well as half of all emergency vehicles need to be "environmentally friendly". Therefore, light utility vehicles should not emit more than 230 gCO2/km.
Effects	An initial ex-ante assessment of the effects of the measures was performed by the Swedish Energy Agency in the year 2007. The assessment showed that the fuel consumption of service vehicles and company cars fell by approximately 20% because fewer kilometres were driven. This can be explained by the fact that users of company cars not only drive more efficiently, but also less.
Transferability to Germany	As in Sweden, company vehicles also make up the largest percentage of new passenger car registrations in Germany (approx. 65% in 2017). In the taxation of electric vehicles, company vehicles in Germany are currently disadvantaged as the higher purchase price generally has a negative effect on the taxation of non-cash benefits. However, existing competitive tax disadvantages are to be rectified. Sweden's example could serve as a starting point in this regard.

4.3.5 Switzerland: Shifting goods traffic onto the rails[13]

Via a comprehensive package of measures, Switzerland was able to achieve significant progress in shifting the transport of goods from the road to the rails.

[12] Sources: IEA, 2014; Odyssee Mure, 2014; KBA, 2017

[13] Sources: UVEK, 2017; BAV, 2018; BAV, 2018; BAV; VIFG

Brief description	Following a referendum in 1994, measures were initiated to reduce the volume of heavy goods traffic in the alpine valleys. In 2000, there were still around 1.4 million heavy goods vehicles traversing the roads of the Swiss Alps, more than half of which in transit traffic. Since then, multiple measures have contributed to a large-scale shift of traffic from the roads to the rails.
The concept	Since early 2001, lorries on all Swiss roads must pay distance, weight and emission-dependent fees (Performance-related heavy vehicle charge (LSVA)). Refunds can be requested for trips to and from handling terminals for rail and shipping traffic. Most of the income from these fees is invested in the construction of the New Railway Link through the Alps (NRLA) with three new base tunnels (Lötschberg, Gotthard and Ceneri). In addition, the north-south axis for transport with a corner height of four metres is being expanded and the construction of handling terminals subsidised. Lorries are also not permitted to drive at night in Switzerland.
Effects	The number of trips by heavy vehicles transporting goods fell by almost a third between 2000 and 2016. Without the measures already implemented, around 650,000 to 700,000 additional lorries would be crossing the Alps each year.
Transferability to Germany	Switzerland's example can in principle be applied to Germany. In Germany, significantly less has been invested per capita in the transport of goods by rail. To date, the income from lorry tolls has primarily been invested in federal highways. In 2018, EUR 4 billion or 71% of the income are expected to be invested for this purpose, while the remainder will, in particular, be used to cover the costs of toll collection.

4.3.6 UK: Local Sustainable Transport Fund[14]

The "Local Sustainable Transport Fund" is an interesting example for a combined promotion of sustainable local public transport and the profitable development of towns and districts.

Brief description	In 2011, the UK implemented the "Local Sustainable Transport Fund" to expand local transport infrastructure and change traffic patterns. By 2015, 96 projects in 77 districts had received a total of GBP 600 million (EUR 680 million) in funding. Due to the high demand and the good quality of the project proposals, the fund received an additional GBP 40 million (EUR 45 million) in 2012.
The concept	Districts are required to submit concrete project proposals in order to receive funding. Funding has been given both for large projects, which have received around half of the funding, as well as smaller projects with a volume of up to GBP 5 million (EUR 5.7 million). Among other things, new bus routes have been introduced, train stations modernised, and new bicycle and pedestrian paths built as a result of the Fund.
Effects	The projects have led to the increased use of buses and bicycles, as well as a decrease in the use of passenger cars in the areas funded. As a result, the per capita emissions in the transport sector fell by around 2 percentage points more than in the areas that did not receive funding. Furthermore, the fund created around 5,000 jobs per year.

[14] Sources: Campaign for Better Transport; Department for Transport, 2017; UK Government; Department for Transport, 2017

Transferability to Germany	The concept is applicable in Germany; however, the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) already funds similar projects through the National Climate Initiative such as the use of hybrid buses and bicycle infrastructure.

4.4 Summary

Based on the emissions and intensity trends as well as other unique sector-specific aspects in the form of interesting policy instruments in the transport sector, various climate protection instruments were examined more closely in section 3.3. The learning effects and transferability to Germany is assessed as being high for the following instruments:

- France: Bonus-malus system for vehicles
- Norway: Incentives for electric vehicles
- Sweden: Taxation of company vehicles
- Switzerland: Shifting goods traffic onto the rails

5 Detailed assessment of the building sector

5.1 Description of the building sectors

The building sector is responsible for a quarter of EU-wide emissions covered by the Effort Sharing Decision. While around a third of ESD emissions in Belgium, the Netherlands, and Switzerland come from this sector, it accounts for less than 10% in Bulgaria, Lithuania, and Sweden. In the Netherlands and Poland, the building sector is the ESD sector with the largest GHG emissions, while it is the one with the lowest emissions in Bulgaria and Portugal.

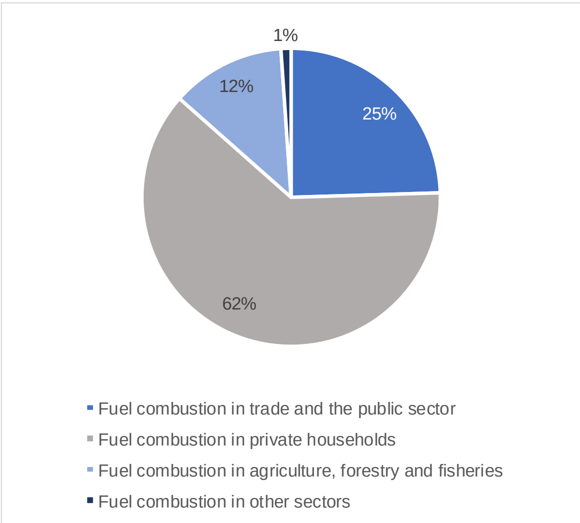

Figure 5: Emissions in the building sector by source sector (2015)

Private households account for around 62% of sector emissions, and the commercial and public sector is responsible for another quarter of the emissions (**Error! Reference source not found.**). The remainder of the emissions come from buildings in the agricultural and other sectors. The emissions in the building sector arise from the provision of heating and cooling of buildings, which means that they can be reduced in particular via energy efficiency measures and more climate-friendly heat generation. Furthermore, the energy requirements of buildings depend on the weather. Since 1990, above-average temperatures in autumn and winter months in many European countries have therefore led to emissions savings in the building sector (EEA, 2017). Furthermore, it should be taken into account that in some cases, the building sector also has an impact on the emissions trends in the ETS sectors via, e.g. combined heat and power generation and district heating or electricity-based solutions for space heating.

5.2 Sector-specific developments

5.2.1 Overview of sector-specific developments

Between 2005 and 2015, EU-wide emissions in the building sector fell by around 19%, but a slight increase was observed in 2015 and 2016. As a result, the sector has contributed significantly to emissions reductions in the ESD sectors. In Germany, the building sector emissions were also reduced by the same amount, but a slight increase in emissions was also observed in 2015 and 2016.

In addition to absolute emissions trends, there are two relevant emissions intensity indicators in the building sector that can help identify successful climate policy measures. The **quantity of emissions per unit of energy supplied in the building sector overall** (EptOE.G_{5-14}) serves as an indicator for decarbonisation in this sector.[15] Because the indicator is not dependent on the overall energy consumption, it is automatically climate-adjusted. At the same time, the **emissions figures for energy provision in households based on living space**[16] allow conclusions to be made regarding emissions intensity in residential buildings, and hence also regarding the effects of any energy efficiency measures in this segment (however, this data is not climate-adjusted).

[15] For targets involving substantial emissions neutrality around the year 2050, the emissions intensity of energy in the heating sector must also approach 0 regardless of the success of efficiency measures.

[16] The base data used for living space considers the overall usable area, which does not correspond to the gross floor area. Parts of buildings that are not heated in winter (attics, cellars, verandas, unheated garages etc.) and common areas in apartment buildings (corridors, stairwells etc.) are not included in the figures.

Table 6: Emissions trends and intensities in the building sector.

Green: emissions and intensity trends in the selected countries; **bold:** the five which achieved the greatest reductions.

Buildings[17]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Absolute emissions trends																															
Emissions	-19%	-20%	-24%	-12%	-37%	-20%	18%	-23%	-56%	-5%	-23%	-27%	-16%	-9%	-8%	-8%	-5%	-34%	46%	-12%	-35%	-8%	-40%	-11%	-42%	-29%	-29%	-44%	-20%	-17%	-26%
Relevant emissions intensities																															
Intensity of the energy supplied in the building sector (*EptOE.G*$_{5-15}$)	-14%	-12%	-22%	-13%	**-38%**	-13%	-4%	-8%	**-40%**	-14%	-21%	-23%	-14%	-19%	8%	-5%	-7%	-20%	-2%	-9%	-31%	-4%	-34%	-8%	**-43%**	-8%	**-36%**	-54%	-8%	-19%	N/A
Intensity per area in residential segment (*Epm*^{2} *WG*$_{5-14}$)	-35%	-33%	-47%	-22%	**-64%**	-33%	-13%	-40%	**-64%**	-35%	-39%	-51%	-33%	-48%	-21%	-8%	-32%	**-52%**	-42%	-34%	-40%	-15%	-38%	-26%	**-56%**	-33%	-43%	-64%	-36%	N/A	N/A

Between 2005 and 2015, **absolute emissions reductions** of up to 44% were achieved in the building sector in all countries examined with the exception of Estonia and Malta (**Error! Reference source not found.**). In these two countries, the building emissions did increase in the observation period, but were below the 1990s-era levels in 2015 in both countries. The emissions intensities also decreased substantially overall. The **emissions intensity per residential area** also fell in all countries, in some cases by up to 64% (Sweden and Denmark). The **intensity of energy supplied** in the building sector fell in all Member States as well as Norway; there was only a slight increase in intensity in Latvia.

[17] Emissions: Eurostat [env_air_gge], CRF 1.A.4 and 1.A.5 for 99%, uniform application per Member State. EptOE.G: Emissions of overall end energy consumption in building stock (residential and non-residential buildings), calculations based on [nrg_110a], added and the cumulative emissions of CRF 1.A.4.a and 4.b. Epm^{2}WG: Comparison of emissions per square metre in residential buildings from 2005-2014 based on the EU Buildings Database by DG ENER with the emissions for CRF 1.A.4.b (no usable time series available for total square metres in non-residential buildings).

5.2.2 Selection of country-sector combinations

Based on national emissions and intensity trends in the sector as well as unique sector-specific aspects in the form of e.g. interesting policy instruments and successes and their relevance with regard to Germany (**Error! Reference source not found.**) and other EU Member States, the following countries will be examined in greater detail: **Denmark, France, Ireland, Latvia, Austria**, **Sweden, Switzerland, Slovakia and the Czech Republic**.

Table 7: Country-sector combinations considered for the building sector

Country	Unique aspects
Denmark	• **High reduction in emissions and emissions intensity.** • In Germany, fossil energy carriers are still being used to generate a large percentage of the country's heat. In Denmark, half of the country's heating needs comes from renewable sources. This is achieved using **district heating systems,** which supply **more than 60% of households** with heat. 70% of district heating comes from combined heat and power generation plants (Danish Energy Agency, 2017).
France	• **High reduction in emissions and emissions intensity.** • In France, the energy consumption in buildings per square metre and year is around 60% higher than in Germany (Housing Europe, 2018).
Ireland	• **High reduction in emissions as well as high reduction in emissions intensity per area in the residential segment.** • In Ireland, both the number of households as well as the average living space have grown significantly since the turn of the millennium (SEAI, 2015). At the same time, the **energy consumption per household decreased by 18% between 2006 and 2011**. • The use of fuel oil, which is comparatively higher than in Germany, is to be increasingly reduced via a **CO_2 tax**. Furthermore, there is also a subsidy programme for building insulation for example.
Latvia	• **High potential for emissions and emission intensity reduction.** • **77% of Latvian homes were built between 1941 and 1992 and have a very low energy efficiency.**
Austria	• **High reduction in emissions and emissions intensity.** • **40% of heating needs** in Austria are supplied by the combustion of **biomass** followed by natural gas and fuel oil (Austrian Biomass Association, 2017). • **Most households in Austria are heated using district heating.** The percentage of district heating from biogenic sources has more than doubled in the last ten years.
Sweden	• **Highest reduction in emissions and emissions intensity among European countries.** • While the majority of heating needs in Germany are supplied using **fossil fuels**, they play only a **marginal role** in Sweden (<3% of energy needs for heating).

Country	Unique aspects
	• Sweden relies on district heating: **51% of households are supplied with district heating**, 45% of which is produced using combined heat and power generation plants (Euroheat & Power, 2017). • The Swedish CO_2 tax (see also section 5.3.6) is also levied in the building sector and has played an important role in reducing the emissions in this sector, both for households as well as the decarbonisation of district heating.
Switzerland	• **High reduction in emissions.** • In Switzerland, the building sector is the largest source of emissions in the ESD segment (BAFU, 2017). • A **CO_2 tax** in this sector also provides incentives to consume less fossil fuels.
Slovakia	• **High emission and moderate emission intensity reduction.** • The building sector accounts for 9% of total CO_2 emissions in Slovakia, which is below the European average (EC, 2015). • The stock of buildings, especially in multi-family houses of Soviet design, has a considerable potential for increasing energy efficiency.
Czech Republic	• **High emission reduction.** • The housing sector has the highest consumption (together with the industrial sector) in the Czech Republic (ODYSSEE, 2018) at around 30%. • In addition, large parts of the single-family household (about 70%) are still in need of renovation (SEF, 2018).

The following countries were not chosen because the emissions and/or intensity reductions can mainly be attributed to the economic crisis, there are structural or climatic differences when compared to Germany, or because the level of ambition of policy measures in the sector is generally low.

Table 8: Countries not chosen in the building sector despite reductions in emissions and/or intensity

Country	Unique aspects
Belgium	• Belgium's progress with energy efficiency measures is moderate, and the level of ambition of the measures is assessed by experts as being low.
Bulgaria	• Comparison with Germany is difficult due to structural differences.
Finland	• Policy measures in Finland have a high level of ambition where energy efficiency is concerned, but further examination is not advisable as the provision of heating is based primarily on district heating and CHP plants, which is already covered by the case study for Sweden.
Greece	• Reduction in emissions primarily due to the **economic crisis**.

Country	Unique aspects
Croatia	• Reduction in emissions primarily due to the **economic crisis**. • Climatic factors make comparison with Germany difficult.
Portugal	• Reduction in emissions primarily due to the **economic crisis**. • Climatic factors make a comparison with Germany difficult.
Slovenia	• Comparison with Germany is difficult due to **structural differences**.
Hungary	• Comparison with Germany is difficult due to **structural differences**. • Relatively low progress with regard to energy efficiency measures. Hungary is also expected to fail to meet its Nearly Zero Energy Buildings (NZEB) target.

5.3 Selected instruments in the building sector

In the building sector, the countries listed in **Error! Reference source not found.** (with the exception of Latvia and Czech Republic) exhibited favourable sector-specific emissions trends, which among other things, is attributable to the policy instruments listed in the following sections. Furthermore, Latvia and the Czech Republic were consulted as they had interesting policy approaches to emission reductions.

The Swedish CO_2 tax also had a significant influence on the building sector. It will be introduced in section 5.3.6 as a cross-sector instrument. The cross-sectoral instrument Sustainable Energy Financing Facility in Slovakia is presented below as it has contributed to investments mainly in the building sector.

5.3.1 Denmark: Energy Performance Certificate Database[18]

The publicly accessible energy performance certificate database in Denmark contributed to increasing awareness for energy efficiency in the building sector.

Brief description	In Denmark, energy performance certificate (EPC) databases have been publicly available online since 1997. In 2006, they were adapted to comply with the requirements of the 2002 EU Energy Performance of Buildings (EPBD) Directive. Denmark was one of the first European countries to introduce a central EPC database.
The concept	The complete EPCs and other information are publicly accessible on the website. The data is reviewed regularly and automatically uploaded to the system. The scope, quality, and accessibility of the Danish EPC database makes it possible for the relevant stakeholders to access and use a wealth of information, fostering an awareness for and contribution to energy savings.
Effects	To date, around a third of the entire Danish residential building stock has been added to the database. The comprehensive information in the database allows e.g. the effectiveness of

[18] Sources: Thomsen, 2014; Loga, 2012; BPIE, 2014

	policy instruments enabling a shift to near zero energy buildings (NZEB) to be assessed. Furthermore, public awareness for energy efficiency in the building sector is heightened, so that there is a proven relationship between the energy certificates and real estate prices in Denmark.
Transferability to Germany	Due to strict data privacy regulations, access to the German EPC database, which has only been in place since the 2014 Energy Saving Ordinance (EnEV 2014), remains restricted to certification experts and the respective state authorities. It only contains metadata and hence no details on the energy-related characteristics of the buildings. However, aggregated data can be published, and building owners can also consent to the publication of their data for selected stakeholders. Denmark's EPC database could serve as a role model for Germany in this case.

5.3.2 France: Tax credit for energy transition[19]

Apart from the CO2 tax, the tax credit for energy transition is one of the most significant climate protection measures in the French building sector.

Brief description	The Tax credit for energy transition (CITE) has been available since 2005 and was simplified in 2015. With CITE, 30% of expenditures for certain measures for improving energy efficiency in residential buildings can be deducted from income taxes.
The concept	Among other things, the tax credit can be used to pay for boilers with high energy efficiency, thermal insulation work, heating regulation devices, heat pumps, or charging stations for electric vehicles, and is limited to EUR 8,000 per person, EUR 16,000 for a couple, and EUR 400 for each additional person. The goal of this regulation is to create incentives for building owners to carry out energy efficiency measures in their buildings. At the same time, efficient new technologies for reducing energy consumption are also to be subsidised to expedite the proliferation of higher performance standards. To ensure that the regulation remains effective, the funding criteria are revised on a regular basis.
Effects	Between 2005 and 2011, more than six million of the 34 million principal residences in France benefited from CITE on at least one occasion. The costs of preventing one tonne of CO2 with the tax credit are estimated at EUR 80 to 90.
Transferability to Germany	Currently, the KfW funding program "Energy-efficient construction and renovation" in Germany already offers financial incentives for energy-efficient renovation. The use of other support programs of the Federal Government for the same measure or the same costs is currently not permitted. The current coalition agreement contains a reference to tax depreciation. In terms of implementation, the shared financing competences between the Federal Government and the Länder is a factor that should be considered or may make transferability more difficult.

[19] Sources: IEA, 2016; UNFCCC, 2017; Sénat, 2017; Erneuerbare Energien, 2015

5.3.3 Ireland: Building Energy Ratings[20]

Compared to Germany, the Building Energy Ratings in Ireland comprise additional components that can contribute to increasing the incentives for investments in energy efficiency measures.

Brief description	Building Energy Ratings were introduced in Ireland in 2010. This assessment system resembles the well-known energy label for devices with a classification from A to G, but has a number of unique, innovative factors.
The concept	Buildings with an A label are characterised by low energy consumption for heating, the provision of hot water, ventilation, and illumination. One unique feature of the ratings are the intermediary levels. For example, it subcategorises A into A1, A2, and A3. This makes the label clear, understandable, and hence consumer-friendly. Attached to the certificate is an expert opinion which informs building owners about recommended energy efficiency measures for increasing energy efficiency. This report is particularly helpful for building owners who have just purchased a building or plan to renovate one. A publicly accessible database lists residential buildings that have already been certified. This database not only provides quality control and market transparency for buyers and interested parties, but also facilitates the collection of statistical data. The publication of energy requirements certificates in the database is also an innovative step.
Effects	The rating provides effective incentives for investments in energy efficiency measures: According to one study, buyers of homes in Ireland are willing to pay up to 10% more for buildings with a good energy rating.
Transferability to Germany	The instrument is partially applicable in Germany. For one, such a system would allow the bar indicator on the German energy certificate with its current nine categories to be divided up into additional subcategories. However, it should be mentioned that due to strict data privacy regulations, access to the German database remains restricted to certification experts and the respective state authorities. Furthermore, it only contains metadata, and no details on the energy-related performance of the buildings.

5.3.4 Latvia: Baltic Energy Efficiency Facility

Brief description	The Baltic Energy Efficiency Facility (LABEEF) was established in 2016 and aims to increase the rate of renovation of apartment buildings in Latvia.
The concept	LABEEF is a company that supports Energy Service Companies (ESCOs) in the long-term financing of renovations through energy performance contracting. Energy performance contracting is a financing model in which the initial investments are refinanced by the long-term savings in energy costs. The contract between the renovating ESCOs and the owners will be forfeited by a third party, meaning taken over. LABEEF enables large financial institutions to audit this financial product (due diligence) by building databases on building

[20] Sources: ESRI, 2013; SEAI, 2017

	inventory and standardizing processes and quality audits, so that they can be won over for small-scale investments of this kind.
Effects	Since 2016, LABEEF has renovated 15 large apartment buildings. In total, Latvia has a building stock of 39,000 multi-family homes in need of renovation, with more than 55 million m^2, which could be renovated by LABEEF. The renovation measures financed by LABEEF can save up to 50% of energy used per m^2. This corresponds to approximately 21 kg/CO_2 per m^2 per year.
Transferability to Germany	In the German context, energy performance contracting has mainly focused on public buildings. The energy agencies of the federal states act as central interfaces. To increase the renovation rate in the private sector as well, LABEEF can serve as an example for multi-family houses.

5.3.5 Austria: Increase in the percentage of renewable energy for heating[21]

The increased use of renewable energy for heating, such as in Austria, can save additional emissions in the building sector.

Brief description	Apart from the energy efficiency of buildings, the nature of the energy source used for heating is also of key importance for the GHG emissions from this sector. In Austria, renewable energy carriers account for around 30% of the overall provision of heating and cooling, which is almost double that of the EU average (16.7%).
The concept	Private households receive financial support in the form of subsidies for biomass and solar heating systems (construction of new systems or boiler replacements) from the federal states and via the Climate and Energy Fund (Klima- und Energiefonds). This support is complemented by informational measures from the federal programme "Klimaaktiv" (lit. "Climate Active") and other measures at the state level. The 2008 Heating and Cooling Lines Act (Wärme- und Kälteleitungsausbaugesetz) aims to reduce electricity needs for climate control in buildings and to expand district heating grids based on industrial waste heat and renewable energy sources.
Effects	The funding measures are expected to save 590,000 tCO2e in 2020 and 1,320,000 tCO2e in the year 2030.
Transferability to Germany	In Germany, a market incentive programme by the Federal Ministry for Economic Affairs and Energy (BMWi) has been in place since 2009 for the use of renewable energy in the heating and cooling market. As part of this programme, private households, companies, and districts can submit funding applications for the construction of renewable energy installations for heating or cooling. In particular, funding is granted for solar thermal installations, heat pumps, or pellet boilers, as well as the construction of heating grids and storage.

[21] Sources: German Federal Environment Agency, 2016; Austrian Government, 2017

5.3.6 Sweden: Innovation clusters / Technology-oriented demand bundling[22]

The technology procurement groups in Sweden contribute successfully to the proliferation of efficient technologies in the building sector.

Brief description	"Innovation clusters" (until 2016: technology-oriented demand bundling or technology procurement groups) were introduced in Sweden in the late 1980s. In the early years, the groups were explicitly geared towards the procurement of technologies (e.g. refrigerators, windows). However, as they gained experience and new groups emerged, the scope of their tasks continuously expanded to include energy-efficient buildings.
The concept	In Sweden's building sector, networks for technology-oriented demand bundling (innovation clusters) promote innovative developments in the building sector by e.g. using demonstration projects to showcase actual savings. The members of the two largest networks are owners of apartment buildings (BeBo) and industrial real estate (BeLok). They receive financial support from the Swedish Energy Agency, so they can share experiences and ideas and develop collaborative demonstration projects. Furthermore, the associated research and development measures also receive funding.
Effects	According to the Swedish Energy Agency, these clusters are highly successful and lead to combined annual energy savings of 0.06 TWh. The total energy consumption of Sweden's building sector is approximately 160 TWh.
Transferability to Germany	To date, there are no directly comparable networks in Germany for technology-oriented demand bundling in the building sector. Landlord and owner associations do discuss energy efficiency measures to some extent, but not on the same scale as in Sweden. There are similar projects in place, but they are usually supported by public policy and not the owners.

5.3.7 Switzerland: The federal and cantonal buildings programme[23]

In addition to the cross-sector CO2 tax (see chapter 5.3.6), the federal and cantonal buildings programme is one of the most important climate protection instruments in the Swiss building sector.

Brief description	The federal and cantonal buildings programme was launched in 2010. Since then, it has promoted the energy-efficient refurbishment of buildings as well as investments in renewable energy, the use of waste heat, and the optimisation of building technology. The origins of the programme can be traced back to a parliamentary initiative from 2002 that sought to remedy the lack of incentives for the energy-efficient refurbishment of rental apartments in particular.
The concept	The programme consists of two parts. Part A of the programme subsidises the refurbishment of the building envelope according to harmonised national standards. For the implementation of this part of the programme, the federal government and the Conference

[22] Sources: Swedish Energy Agency, 2015; Odyssee-Mure, 2017; Energy Efficiency Watch, 2013

[23] Sources: BAFU, 2017; Bundesrat (Federal Council), 2016

	of Cantonal Energy Directors signed a programme agreement with a quantitative outcome target. In part B of the programme, the federal government provides support in the form of contributions to the various cantonal funding programmes for the use of renewable energy, the utilisation of waste heat, and building technology. The cantons must contribute at least half of the required funding from their own budget. Since 2010, a third of the proceeds from the CO_2 tax in Switzerland are used for the building programme.
Effects	Between 2010 and 2014, around one billion Swiss francs (EUR 860 million) in funding was paid out to private households. The annual emissions reductions from the measures funded between 2010 and 2014 amount to 600,000 tonnes of CO_2, which is equivalent to around one third of the emissions reductions in the Swiss building sector during this period. The funding efficiency (152 francs or EUR 140 per tonne of CO_2 was in fact better than initially expected). Also, where the refurbishment of building envelopes was concerned, expectations were exceeded. In this case, tapping into the considerable potential of building envelope surfaces that had not yet been energy-optimised, turned out to be a resounding success. By bringing about a transition from double to triple glazing, funding in the window segment has contributed to a permanent change in the market.
Transferability to Germany	The KfW subsidy programme "Energy-Efficient Building and Refurbishment" (Energieeffizient Bauen und Sanieren) already provides financial incentives for energy-efficient refurbishment in Germany. A combination with other federal programmes for the same measure, i.e. the same costs, is not currently permitted.

5.3.8 Slovakia: Energy Efficiency Facility SlovSEFF[24]

Brief description	The European Bank for Reconstruction and Development (EBRD) has been providing a special credit line (facility) to finance renewable energy projects and energy efficiency measures in the Slovak Republic since 2007. The focus for the use of the loans is on renewable energy and energy efficiency measures in industry and residential buildings.
The concept	By providing a facility, the EBRD grants credit lines to local financial institutions to establish energy efficiency financing as a permanent business. Local financial institutions lend the funds to their clients (mainly small and medium-sized enterprises and private customers) to encourage investment. Within the framework of SlovSEFF, three categories of projects are eligible: renewable energies (maximum project size: EUR 10 million), industrial energy efficiency (maximum project size: EUR 5 million) and energy efficiency projects for residential buildings (maximum project size: EUR 2.5 million).
Effects	By 2015, SlovSEFF supported more than 700 energy efficiency projects and renewable energy investment projects, with a cumulative investment of around EUR 200 million in total. By 2014, these measures resulted in an estimated annual primary energy saving of 582 GWh. SlovSEFF I and II, which were launched in 2007 and 2010 respectively, reduced CO_2 emissions in the Slovak Republic by 115,000 tonnes per year.

[24] Sources: SlovSEFF, 2018; EBRD, 2014; EBRD, 2015

Transferability to Germany	With regard to transferability, it is doubtful that an instrument similar to the SlovSEFF facility would lead to significant additional emission reductions in Germany, since a large number of similar financing instruments already exist and German banks generally already have the necessary capacity and liquidity. For EU member states with similar sectoral conditions and liquidity deficits in the banking sector; however, a facility similar to SlovSEFF could be a useful tool to promote energy efficiency and reduce emissions in both the building and industrial sectors.

5.3.9 Czech Republic: New Green in Savings (NGiS) programme

Brief description	The New Green in Savings (NGiS) programme was continued by the Czech Ministry of the Environment in 2014 and runs until 2021. The program is managed by the State Environmental Fund (SEF) and receives most of its financial resources from the Sale of EU emission allowances (SFZP, 2018). The main objective of the program is to reduce greenhouse gas emissions through end-energy savings and the introduction of emission-friendly heat generation technologies.
The concept	The NGiS program comprises three funding areas (A-C) for single and multi-family houses as well as public buildings: A. Improvement of energy efficiency (especially insulation measures) B. Construction of very energy efficient buildings (up to passive house standard) C. Efficient use of energy sources (e.g. regenerative heat producers) The NGiS covers up to 50% (detached houses) or 30% (multiple dwellings) of the total eligible expenditure. Owners or builders of single and multi-family dwellings (both natural and legal persons and since 2016 public buildings) are eligible (MURE, 2018). The State Environmental Fund (SEF) will review applications for the program either until the end of the project (31 December 2021) or until funds are exhausted. The most frequent applicants are individuals (not entrepreneurs) (SEF, 2018).
Effects	The latest data from the State Environmental Fund for Single-Family Housing show the following effects (SEF, 2018, as of 10.09.2018): Single: 75% of the applications have been accepted so far, which represents 65% of the total requested (around EUR 150 million), and most of the applications were for Area A (improving energy efficiency, 63%). Multi-family houses: 67% of the applications have been accepted so far, which is 60% of the total requested (about EUR 9 million), most of the applications were for sub-area A (energy efficiency improvement, 85%). The NGiS program (2014-21) is one of the most efficient programs in the Czech Republic. Based on the experience of the program, savings of about 1 terajoule (TJ) can be achieved with EUR 58,500 in funding (SEF, 2018). The emissions reductions of the NGiS program (2014-21) are estimated to be around 1 million tCO_2e per year by 2020. The production efficiency is about 155 EUR/tCO_2e (EEA, 2018).
Transferability to Germany	Similar political instruments supporting areas comparable to that of the NGiS (renovation, low-energy buildings, efficient heating systems) already exist in Germany. Nevertheless,

some experiences from the Czech program, such as a reduction of bureaucracy and administrative barriers can be transferred to the German programs.

The Czech NGiS program can serve as a model for Member States with an energy mix and remediation structures similar to that of the Czech Republic.

5.4 Summary

In the preceding section, various instruments were presented and examined more closely based on the emissions and intensity trends achieved as well as other unique sector-specific aspects such as interesting policy instruments. Detailed factsheets were prepared for the following instruments as they are assumed to be highly transferable to Germany or other EU Member States. In the case of similar policy instruments (e.g. energy rating for buildings in Ireland and building energy performance certificate database in Denmark), the instrument with the greater learning effects was selected to be analysed further.

- Denmark: Energy Performance Certificate Database
- France: Tax credit for energy transition
- Sweden: Innovation clusters / Technology-oriented demand bundling
- Slovakia: Energy Efficiency Facility SlovSEFF
- Czech Republic: New Green in Savings programme

6 Detailed assessment of the industrial sector

6.1 Description of the industrial sector

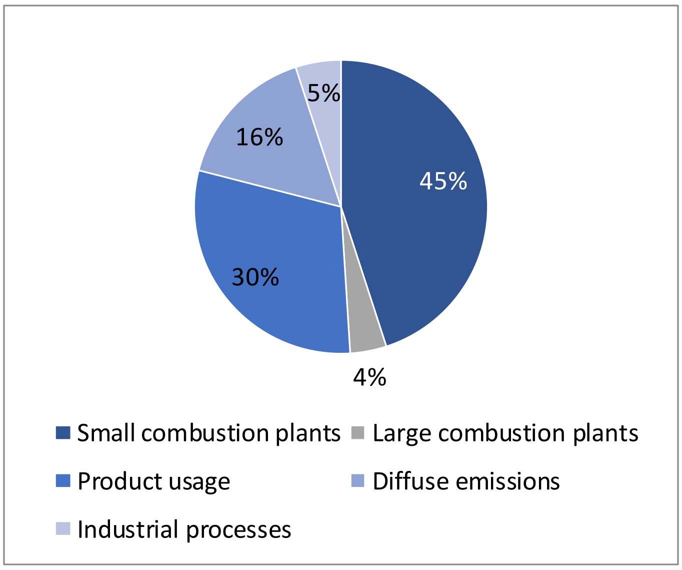

Figure 6: Emissions in the industrial sector by source type (2015)

The ESD sector Industry encompasses all emissions that are generated in the energy industry and manufacturing economy and not covered by the ETS, as well as all emissions that originate from the utilisation of industrially manufactured products. These source sectors generate approximately a sixth of total ESD emissions in the EU.

National reporting and classification of emissions as part of the United Nations Framework Convention on Climate Change (UNFCCC) differ greatly from the reporting of the ETS. Hence, national ESD and ETS percentages in the industrial sector cannot be clearly distinguished from each other. During the observation period (2005–2015), the framework of the ETS also changed. Furthermore, due to the optional exception in the ETS for installations between 20 and 30 MW, there may be minor differences amongst the Member States when distinguishing between ETS and non-ETS industrial installations.

In its calculations of emissions from the industrial sector, the European Environment Agency assumes for the current scope of the ETS that, EU-wide, 10% of emissions in the energy industry (both direct and diffuse emissions), 29% of emissions from the combustion of fuels in the industrial sector, and 40% of process emissions and emissions from product use, fall under the ESD.[25] Because of the varying emissions generated in these three source sectors overall, approximately the same amount of ESD emissions can be attributed to each of the three segments. The detailed composition of the emissions in the ESD sector Industry can be estimated based on these assumptions via approximation.

Almost half of the emissions in the ESD sector Industry come from **small combustion installations** in the energy and manufacturing industry that do not fall under the ETS due to their low capacity[26] (**Error! Reference source**

[25] Emissions from product use comprise various gases which are released immediately or with a delay during the use of products. Currently, they consist mainly of F-gases which are stored in refrigeration units. In addition to F-gases, also subsumed under this term are a wide range of refinery products that are not used as fuel (solvents, paraffin, various lubricants, asphalt emissions etc.) as well as smaller emissions sources such as the use of nitrous oxide in spray canisters and in medicine.

[26] In this case, approximately 45% of EU-wide emissions are generated from the combustion of fuels in small combustion installations, including non-stationary sources in the construction industry, as well as approx. 5% as process emissions, such as in the electronics industry and in smaller installations in the glass and ceramics industry.

not found.). The other half of emissions consists of diffuse emissions that are released during energy generation and transport, secondary gases (methane and nitrous oxide) from large installations that do fall under the ETS for CO_2, and emissions arising during product use, such as F-gases as coolants.

Upon closer examination of the emissions from **product use**, it is clear that there are almost no purely national policy measures that directly target reductions in this ESD sector.[27] This is probably due to the fact that product policies in the EU can only be regulated to a limited extent at the national level. **Diffuse emissions** from the energy industry (incl. those caused by outgassing, burning off, and evaporation) are generated primarily during the extraction of oil and gas, the mining of coal (above all in mines), and to a small extent in the refining, transport, and storage of fuels. For Germany, the emissions are now significantly less relevant than for other EU countries and are expected to decrease in significance even further after the closure of the last mine in Bottrop (December 2018).

Based on these observations, it is clear that from a policy standpoint, measures that directly target **small combustion installations** are the most interesting for further examination. This sector comprises numerous small and medium enterprises (SMEs), but also includes many large companies with a low energy intensity or a high degree of electrification in their production processes, such as in machine engineering or the automobile industry. Among other things, emissions from small combustion installations can be reduced via more efficient steam boiler installations, the use of GHG-neutral fuels, electrification, or improved industrial processes.

6.2 Sector-specific developments

6.2.1 Overview of sector-specific developments

The emissions in the ESD sector Industry are estimated to have fallen by around 22% between 2005 and 2015. Due to the effects of the economic and financial crisis, a particularly stark decrease in emissions was observed in 2009, but the emissions in the sector have continued to decrease since 2010. In Germany, however, the sector's emissions fell by only 7% during the observation period, and a slight increase in emissions was observed in 2015.

As described above, the challenge experienced in the ESD sector Industry is that the available emissions data make it difficult to distinguish between the installations relevant for the ESD sector and the larger installations covered under the ETS. The data used to conduct a comparison of the economic development of the sector also do not allow a distinction to be made between ETS and ESD installations. Hence, for an initial estimation of the possible success of policy measures, the industrial sector was examined as a whole. In addition, as the only sub-sector of the industry that falls almost completely within the ESD, the construction sector is considered separately.

Furthermore, it should be noted that for the industrial sector, absolute emissions values are not particularly meaningful due to structural change and de-industrialisation effects, as well as the sector's strong dependence on general economic development. Due to this, it is primarily **emissions intensity** that is used in this sector as an indicator for climate policy progress, expressed as **emissions per added value in the industrial sector**

[27] In the "Policies and Measures Database" of the European Environment Agency (EEA), there are only a few measures which are not based directly on EU legislation, among them an innovation programme for sustainable cooling in France.

(I.NACE.I$_{8\text{-}15}$). In addition, the **added value-based emission intensity in the construction sector (I.NACE.C$_{8\text{-}15}$)** is also considered.

Table 9: Emissions trends and intensities in the industrial sector.

Green: emissions and intensity trends in the selected countries; **bold:** the five countries with the greatest reductions in absolute emissions as well as the relevant intensities.

Industry[28]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Emissions trend																															
Emissions	-22%	-26%	-21%	-19%	-37%	-7%	-14%	-22%	**-31%**	**-34%**	-25%	-32%	-34%	-5%	1%	-23%	-25%	-21%	-13%	-14%	-4%	-5%	-18%	**-35%**	-28%	-17%	-20%	-23%	-31%	-11%	-8%
Relevant intensities																															
Intensity of the industrial sector excl. construction (*I.NACE.I*$_{8-15}$)	-21%	-27%	-22%	-21%	-36%	-18%	-29%	**-64%**	-2%	-15%	-27%	-18%	-20%	8%	-7%	**-41%**	-37%	-26%	N/A	4%	-14%	-29%	-9%	**-32%**	-26%	-34%	-8%	-11%	-30%	3%	-18%
Intensity of construction sector (*I.NACE.C*$_{8-15}$)	11%	20%	56%	**-30%**	1%	5%	3%	59%	-12%	**-36%**	24%	8%	69%	24%	4%	-18%	-21%	19%	N/A	-5%	9%	**-55%**	-4%	32%	**-28%**	-18%	8%	6%	-8%	0%	**-22%**

[28] Emissions: Eurostat [env_air_gge], CRF 1.A.1, 1.B and 1.C for 10%, CRF 1.A.2 for 29% and CRF 2 for 40%, uniform application of the respective source categories to the Member States. The subdivision of the source categories cannot be mirrored with economic data, hence a comparison of the total emissions incl. ETS: I.NACE.I: Comparison of added value of the industrial sector except for the construction sector in total, concatenated[env_ac_aeint_r2], non-construction sectors added. I.NACE.C: Comparison of the emissions of the construction sector according to [env_ac_aeint_r2] with the concatenated added value data of the construction sector (as above).

In Norway, Switzerland, as well as in all Member States with the exception of Latvia, the **absolute emissions** in the sector decreased during the observation period, in Romania even by 35% and in Denmark by 37% (**Error! Reference source not found.**). The **emissions intensity for the industrial sector** also fell significantly in most countries. However, the intensity increased in Cyprus, the Netherlands, and Norway. The **emissions intensity in the construction sector**, which includes non-stationary sources and is generally completely covered by the ESD, increased dramatically in many countries as a consequence of the production slump in the sector due to the economic crisis from 2008 onwards; even rising by more than 50% in Bulgaria, Ireland, and Italy. In Poland, on the other hand, the intensity dropped by more than 50%.

6.2.2 Selection of country-sector combinations

Based on the development of these key indicators[29] and their relevance with regard to Germany, the following countries will be examined more closely in the ESD sector Industry: **Belgium**, **Denmark**, **France**, **Sweden**, **Slovakia**, and the **UK**. A detailed justification of the selection can be found in the following tables.

Table 10: Country-sector combinations examined in the ESD sector Industry

Country	Unique aspects
Belgium	• **High reduction in emissions and emissions intensity except in the construction industry.** • Use of primarily **voluntary agreements with the industrial sector** to achieve emissions reductions.
Denmark	• **Highest reduction in emissions and emissions intensity except in the construction industry among European countries.** • Unlike Germany, which utilises financial incentives to promote climate protection in the industrial sector, there are **cross-sector energy efficiency obligations** in Denmark.
France	• **High reduction in emissions and emissions intensity except in the construction industry.** • The sector is in part covered by the comparatively **high CO_2 tax**.
Sweden	• Medium reduction in emissions and emissions intensity except in the construction industry. • A very **high CO_2 tax** also covers a portion of industrial installations that do not fall under the ETS. The processing industry outside of the ETS pays 30% of the general energy tax for fuels used in industrial production processes.
Slovakia	• Medium reduction in emissions as a result of a classic structural transition to sectors with a higher added value and lower consumption of fossil fuels. • In Slovakia, policy instruments for reducing greenhouse gases targeting the industrial sector can be attributed primarily to a **successful implementation of EU legislation** compared to other EU countries.

[29] In order to prevent the trend from being caused above all by industrial segments under the ETS, a comparison of the development in the sub-sectors was made.

Country	Unique aspects
UK	• **High reduction in emissions and emissions intensity except in the construction industry.** • Industrial companies can enter into **Climate Change Agreements** specifying voluntary emissions reductions with the British Environment Agency.

The following countries were not chosen for further analysis even though some of them achieved emissions and/or intensity reductions because it was not possible to clearly attribute the emissions trends to corresponding policy instruments and/or comparability with Germany is limited. Also, there were difficulties distinguishing ETS emissions in the industrial sector in these countries.

Table 11: Countries not chosen in the industrial sector despite reductions in emissions and/or intensity

Country	Unique aspects
Estonia	• Slight reduction in absolute emissions while maintaining a **very high emissions intensity** of the sector (four times higher than in Germany).
Ireland	• Distorted statistics.
Lithuania	• Significant reduction in emissions although the industry has experienced good economic development. • The **high reduction in emissions** in the industrial sector for the period 2005-15 (as well as 2008-15), however, is primarily **due to two mutually linked joint implementation projects**. In Germany, there were similar projects in the former East German states; however, since 2013 the relevant process emissions fall under the ETS framework. • **Few industry-related policy instruments** for reducing greenhouse gases.
Luxembourg	• Significant **reduction in emissions intensities in the industrial sector, but particularly in sectors under the current ETS framework**. • The perceptible reduction in final energy consumption in the industrial sector is related primarily to reductions in the ETS sector.
Poland	• Slight reduction in emissions while maintaining a **very high emissions intensity** of the sector (more than three times higher than Germany).
Romania	• **Emissions reductions** have been achieved primarily in the **ETS sector**.
Slovenia	• Emissions intensities have decreased significantly since 1990, apart from a peackin in 2005-2007. • The **reduction in emissions** since 2005 is primarily due to the 2008 **economic crisis**, which above all, led to a decrease in production in the heavy industries, meaning it should be attributed to the ETS instead of the ESD sector[30].

[30] (Government of Slovenia, 2018)

6.3 Selected instruments in the industrial sector

For the ESD sector Industry, the countries listed in Table 10, which exhibited above-average sector-specific emissions trends as well as significant policy instruments with a particular relevance with regard to Germany and other Member States, were selected. However, it should be taken into account that the measures listed below also affect emissions in the ETS sector to some extent.

6.3.1 Belgium: Tax deduction for energy savings[31]

The corporate tax deduction for energy savings is one of the most significant measures for increasing energy efficiency in Belgium's industrial sector.

Brief description	In order to promote increased energy efficiency in the industrial sector, companies in Belgium can deduct their investments in energy efficiency measures from the tax on their earnings. The tax deduction for energy savings was introduced in 1992 and has increased since. Since 2015, the one-off tax deduction amounts to 13.5%.
The concept	Via tax breaks, industrial companies in the ESD and ETS sector have incentives to invest in energy efficiency measures. If corporate profits are not sufficiently high to take full advantage of the tax deduction, the deduction can also be applied in the following years.
Effects	For 2018, savings of 710,000 tCO_2e are predicted, a significant annual emissions reduction in the Belgian context. However, it should also be noted that the emissions are, in part, also saved in the ETS sector.
Transferability to Germany	Tax breaks could, where applicable, be combined with existing financial subsidy instruments of the KfW and other federal funding guidelines.

6.3.2 Denmark: Energy efficiency obligations[32]

The energy efficiency commitment system in Denmark is a good example of an effective cross-sector policy instrument that has been able to take almost full advantage of the technical and economic potential for energy efficiency in the industrial sector as well.

Brief description	Denmark utilises energy efficiency commitments with companies from the energy sector in order to achieve the target of the EU's Energy Efficiency Directive, which specifies a 20% reduction in primary and end energy consumption by 2020. The programme builds on the dialogue between organisations from the government and the sector, which has existed since the 1990s and is welcomed by companies in particular because of the ample co-determination opportunities the scheme offers as compared to the normal legislative process. In its current form, the obligations system has existed since 2012. The obligated companies carry out energy efficiency measures at the end customer either themselves or via commissioned third parties. The savings achieved are credited towards the goal.

[31] Sources: Deloitte, 2017; ICEDD, 2017

[32] Sources: ENSPOL, 2015; Bertoldi, Castellazzi, Oikonomou, & Fawcett, 2015; BigEE, 2018

The concept	In an initial step, the Danish Energy Agency (DEA) compiles a proposal for the obligation based on an assessment of the current market situation and technological developments. The general political framework and the targets are defined by the government after an agreement regarding the obligation has been established in parliament. The targets are defined both for the electricity and the gas sector and are proportional to the average market share of the electricity or gas supply in the three preceding years. In Denmark, three gas companies, six oil companies, 74 electricity companies, and 417 district heating companies participate in the obligations programme. With a few exceptions, all technologies can be utilised for energy savings, but there are exceptions for technologies for which the additionality of measures is assessed as low. The energy efficiency commitments are financed by end consumers via their energy bills.
Effects	Experiences from Denmark show that the industrial sector can realise energy savings in a highly cost-effective manner. The efficiency obligations address industries in both the ETS and non-ETS sectors. Furthermore, weighting factors are used in Denmark in order to also implement measures with a long lifetime.
Transferability to Germany	The impact of an energy efficiency commitment depends in particular on the number of companies that have committed to it as well as the overall target. While Germany currently fulfils the obligations of the Energy Efficiency Directive exclusively via alternative policy measures and has a range of energy efficiency measures, an energy efficiency commitment could also become part of this package of measures. However, an energy efficiency commitment in Germany would need to be adapted to national actors and the existing savings potential in various sectors.

6.3.3 Denmark: Initiative "Renewables for the Industry"[33]

The initiative "Renewables for the Industry" can be seen as a supplementary measure for policy instruments with a focus on increasing energy efficiency in the industrial sector.

Brief description	The initiative "Renewables for the Industry" ran from 2012 to 2016. The fund for providing industrial companies with subsidies for switching to renewable energy comprised a volume of 3.75 billion crowns (EUR 500 million).
The concept	Companies were able to apply for subsidies for switching to the use of renewable energy (biomass, solar, or wind energy) or district heating instead of using fossil energy carriers (coal, oil, or gas) in production processes. Investments in energy efficiency measures were also eligible for subsidies.
Effects	It is estimated that the initiative will save one million tonnes of CO_2 per year in the ETS and ESD sectors from 2020 onwards.
Transferability to Germany	The initiative is generally transferable to Germany. In Germany, there are already similar funding programmes by the KfW as well as other federal funding guidelines.

[33] Source: Danish Ministry of Energy, Utilities and Climate, 2017

6.3.4 Sweden: Energy audit subsidies for SMEs[34]

Via the subsidy system in Sweden and the audits it finances, energy consumption can also be reduced in SMEs.

Brief description	Since 2010, SMEs with an energy consumption of at least 300 MWh per year can apply for financial subsidies for energy audits. Agricultural enterprises with at least 100 farm animals are also eligible for the subsidy.
The concept	Companies can be reimbursed for up to 50% of their energy audit costs (max. 50,000 crowns or EUR 5,300) by the Swedish Energy Agency. In order to be eligible, the audit must include an energy mapping, proposed measures, and an energy plan. The implementation status of the measures will be reviewed after a few years.
Effects	An evaluation based on audits in the years 2010 to 2012 indicated that companies were able to reduce their energy requirements by approximately 20% through the audits. This corresponds to energy savings amounting to 237 kWh/EURwhich was spent as part of the programme.
Transferability to Germany	In Germany, just like in other EU Member States, energy audits are mandated for large companies. By promoting energy audits for SMEs, additional mitigation effects can be achieved. The Swedish approach is easily transferable and is already implemented through similar programmes for energy consultation and funding for SMEs in Germany, such as the SME Initiative Energiewende and Climate Protection and Energieberatung Mittelstand. In Germany, up to 80% of consultation costs can be subsidised as part of the Energieberatung Mittelstand programme. Depending on energy costs, up to a maximum of EUR 6,000 is granted in funding. Hence, the learning effect for Germany is limited.

6.3.5 Sweden: : CO_2 tax[35]

Due to its high price signal, Sweden's CO2 tax can be seen as an extremely effective example of a cross-sector instrument that has a particular impact on the ESD sector Industry as well.

Brief description	Sweden's CO_2 tax was introduced in 1991 as part of a comprehensive tax reform which also reformed energy taxes and is levied on all fossil energy carriers. It is currently the most drastic CO_2 price signal in the world and sets a price on energy emissions in the industrial, building (heating) and transport sectors that are not covered under the EU's ETS.
The concept	The CO_2 tax is levied together with other taxies on energy carriers. However, unlike the general energy tax, it targets emissions instead of the energycarrier. The electricity sector is exempt from the CO_2 tax (but is also almost completely emissions-free).
Effects	The CO_2 tax has contributed substantially to the almost complete decarbonisation of the Swedish heating sector and, despite a low tax rate, also had an influence on the industrial sector, above all via a strong reduction in emissions intensity. An effect has also been recorded in road traffic, with an estimated emissions reduction of almost 10%.

[34] Sources: Swedish Government, 2017; IEA, 2017

[35] Sources: Andersson, 2017; Bohlin, 1998; Brännlund, Lundgren, & and Marklund, 2014; Scharin & Wallström, 2018

Transferability to Germany	A reform of taxes and levies in the energy sector would be possible in Germany and could set a strong price signal for CO_2. Compared to Sweden, Germany is characterised by a highly coal-intensive electricity mix and the limited availability of bio-energy, such that other technological options would need to be incentivised in order to achieve comparable emissions reductions.

6.3.6 Slovakia: Grant programme for energy savings and the use of renewable energy[36]

The grant programme for energy savings and the use of renewable energy can be viewed as a good example for climate protection measures in the industrial sector in central and eastern Europe.

Brief description	As part of the European Regional Development Fund Operational Programme for Slovakia for the phase 2007-2013, a grant programme for innovation and technology transfer as well as a grant programme for energy efficiency measures in the industrial sector in Slovakia were launched. It involves the continuation and expansion of an existing grant programme under the previous Operational Programme. The programme continued to remain operational even after the end of the programme phase.
The concept	Above all, the programme finances investment measures with a focus on SMEs, but also finances measures in large companies. Measures eligible for financing include e.g. a switch to biofuels or other forms of renewable energy, the construction of highly efficient CHP plants, and the modernisation of combustion installations. Companies are eligible for grants amounting to EUR 20,000 to 200,000 for small projects and grants amounting to EUR 60,000 to 2,000,000 for large-scale projects. In the economically stronger regions around Bratislava, the maximum grant amount is 40% of the costs and in the remaining regions of Slovakia it is 50%. The annual funding volume for the 2014-16 period was approximately EUR 9 million.
Effects	According to the National Energy Efficiency Action Plan, the programme resulted in savings of around 590 TJ per year in the 2014-2016 period. Furthermore, according to an ex-ante estimate, the share of renewable energy in the energy mix increased by 4.6 percentage points. A detailed quantification of CO_2 savings due to the programme does not exist.
Transferability to Germany	In Germany, there are similar funding programmes for investment measures in the industrial sector at the national and state levels. They are further categorised in much more detail according to their scope (electricity efficiency, CHP, renewables etc.). They are generally also open to all technologies. The financing is provided in part by the EU. Likely because it is embedded in the European Funds for Regional Development (ERDF), the funding amounts for investment measures in Slovakia may be higher than the EU would permit for Germany. Hence, the transferability of the instrument is limited.

[36] Sources: Slovak Ministry of Economy, 2009; MURE, 2008

6.3.7 UK: Climate Change Agreements[37]

In addition to the energy efficiency commitments in Denmark, the Climate Change Agreements in the United Kingdom can be seen as another example of effective commitments for companies.

Brief description	The Climate Change Agreements (CCAs) were introduced in 2001 in order to maintain the competitiveness of companies that need to pay the Climate Change Levy (CCL) and at the same time promote energy efficiency in the industry. The programme was revised in 2013 in order to simplify reporting and increase transparency in the programme.
The concept	Energy-intensive companies can enter into voluntary agreements on emissions reductions with the British Environment Agency in order to be granted a rebate on the CCL. After a period of two years in each case, the levy on electricity is reduced by 90% and by 65% for other fuels if the target is achieved.
Effects	In the first phase of the new CCA programme, the targets in most sub-sectors were achieved and comprehensive investments were made in energy efficiency measures. Between January 2013 and December 2014, the emissions of participating companies reduced by approximately 12%.
Transferability to Germany	Germany could utilise the UK's experience to consider industry-specific agreements for example. For Germany, it could be relevant to compile a database for this purpose, which sets industry-specific consumption benchmarks for electricity and heat consumption.

6.3.8 Summary

Based on the emissions and intensity trends in the ESD sector Industry and after a comparison with the development of sub-sectors in the EU Member States, Norway, and Switzerland, various instruments were examined more closely in section 5.3. Transferability to Germany was assessed as being high for the following instruments:

- Belgium: Tax deduction for energy savings
- UK: Climate Change Agreements
- Sweden: CO_2 tax
- Denmark: Energy Efficiency Obligations

It is conceivable to transfer instruments similar to those in section 6.3 to Germany, but for the more detailed factsheets, only instruments were selected that could provide new impetus and go beyond the existing instrument mix in Germany.

[37] Sources: Ricardo Energy & Environment, 2017; Environment Agency, 2015; European Commission, 2017

7 Detailed assessment of the agricultural sector

7.1 Description of the agricultural sector

Emissions in the agricultural sector are generated e.g. by digestive processes in animals, the storage of solid and liquid manure, as well as heavily fertilised fields. Via these processes, methane, nitrous oxide, and to a smaller extent ammonia, are released. The impact of methane and nitrous oxide emissions is significantly higher than that of CO_2 emissions. Methane and nitrous oxide are more potent greenhouse gases than carbon dioxide (methane = 25 times, nitrous oxide = 298 times) (UBA, 2016). These emissions are generated along the entire process chain of agricultural operations. Methane emissions are generated via the digestive processes of ruminant animals as well as the storage and application of liquid and solid manure as fertiliser. Nitrous oxide emissions are caused by the use of nitrogen-based fertilisers (UBA, 2017). Furthermore, the amount of emissions is determined by breeding and cultivation methods.

Indirect emissions due to changed land use are not included in the GHG emissions of the agricultural sector; the same applies for CO_2 sinks and forestry management processes, which are separately accounted for in the land use sector. Emissions that can be traced back to the operation of agricultural machines or the heating and ventilation of stalls are attributed to the energy sector. Overall, the agricultural sector generates approximately 10% of GHG emissions EU-wide (UBA, 2017). In Germany, the emissions generated by agriculture in 2015 accounted for 7.4% of total emissions.

A large portion of GHG-reducing activities in the agricultural sector takes place via the implementation of EU directives at national level. Furthermore, EU subsidies as part of the Common Agricultural Policy (CAP) as well as grants from the European Agricultural Fund for Rural Development (EAFRD) also play an important role.

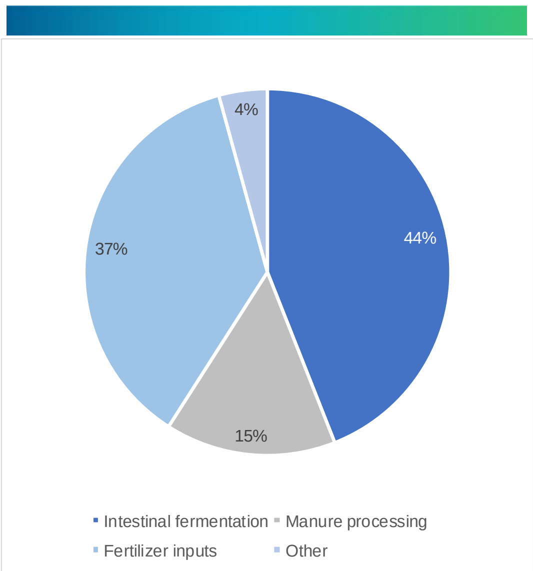

Figure 7: Agricultural emissions according to source sector (2015)

7.2 Sector-specific developments

7.2.1 Overview of sector-specific developments

The EU-wide emissions from the agricultural sector have fallen in the period between 2005 and 2015. The same applies for the emissions intensity of the sector. In numerous countries, this is due to a reduction in livestock. Furthermore, extensive increases in efficiency were achieved, via the more efficient feeding of livestock, and the more targeted use of fertilisers. After initial successes with emissions reduction, only minor successes in this area were achieved in the past few years. In the German agricultural sector, both the overall emissions as well as the emissions intensity of the sector in the period observed increased.

For the agricultural sector, relevant intensities are more difficult to define compared to other sectors, as it is not an energy sector in which the end product (mobility, heat) can easily be measured. Hence, data on added value will be used for calculating intensity.

Because the definition of the agricultural sector for the purposes of added value is not identical to the ESD definition, both data series will be presented. The following table contains values on the trends for the **absolute agricultural emissions (Em ESD)** as well as the **absolute emissions of the sector** based on a slightly broader definition of all energy and other emissions attributed to this sector ($E.NACE.L_{8-15}$). The first value specified here is more meaningful with regard to the emissions trends in the ESD sector Agriculture; the largely congruent second value increases our confidence that the intensity based on this value is meaningful. The **emissions intensity of the agricultural sector ($I.NACE.L_{8-15}$)** is based on NACE Values on added value as well as emissions.

For the interpretation of the aforementioned values, additional context variables are of particular significance, as they can be used to explain changes in emissions not induced by climate policy (e.g. emissions-relevant activity shifts within the agricultural sector from animal husbandry to crop cultivation or vice versa; structural shifts away from agriculture, but also a significant expansion of agricultural activities in a number of Member States).

Table 12: Emissions trends and intensities in the agricultural sector

Green: emissions and intensity trends in the selected countries; **bold:** the five countries with the greatest reductions in absolute emissions as well as the relevant intensities.

Agriculture[38]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Emissions trend																															
Agricultural (emissions *Em ESD*)	-1%	-3%	20%	3%	-5%	6%	18%	0%	-7%	-4%	0%	**-16%**	-8%	**-10%**	22%	4%	7%	10%	**-12%**	2%	1%	0%	0%	**-9%**	-2%	0%	0%	-3%	-3%	-1%	0%
Emissions of the agricultural sector *(E.NACE.L$_{8-15}$)*	-1%	-1%	**-9%**	2%	-5%	4%	0%	2%	**-21%**	4%	-2%	-14%	-5%	**-8%**	17%	4%	3%	12%	**-18%**	1%	-2%	-5%	-1%	**-7%**	0%	0%	-3%	-3%	1%	0%	N/A
Relevant intensities																															
Intensity of the agricultural sector (*I.NACE.L$_{8-15}$*)	0%	4%	22%	-16%	-27%	50%	**-30%**	-2%	**-31%**	2%	-11%	32%	-7%	21%	**-23%**	-12%	-14%	42%	N/A	-7%	4%	-1%	-2%	-5%	-6%	**-18%**	-3%	43%	-6%	4%	N/A

[38] ESD emissions: Eurostat [env_air_gge], CRF3 overall. E.NACE.L: Overall emissions of the economic sector Agriculture and Hunting (NACE A01) in all source categories based on [env_ac_ainah_r2] in the period 2008-2015. I.NACE.L: [env_ac_aeint_r2]

Between the Member States, there are comparatively large differences in **absolute emissions reductions** as a result of drastically different starting points (**Error! Reference source not found.**). For example, the emissions of the sector increased by 20% between 2005 and 2015 in Bulgaria, while they fell by 8% in Italy. Emissions reductions with a parallel reduction in **emissions intensity** are observed only in a very small number of countries. Denmark achieved the greatest success in this regard — it reduced its overall emissions by 5% while simultaneously reducing intensity by 27%. The most significant reduction in GHG intensity in the agricultural sector was observed for Greece, with a reduction of 31%. On the other hand, this intensity increased by 50% in Germany during the observation period.

7.2.2 Selection of country-sector combinations

Based on the key indicators described, the significance of the agricultural sectors in the individual countries, as well as comparability with Germany, the following countries will be subjected to more detailed analysis: the **Netherlands, Denmark, Finland, Italy, France,** and the **UK**.

Table 13: Recommended country-sector combinations in the agricultural sector

Country	Unique aspects
Denmark	• **Significant emissions reductions** were achieved **over the past few years.** • Denmark is one of the few countries in which a reduction in emissions is not due primarilyto a smaller livestock population, which makes it a particularly **interesting case study**.
Finland	• **High reduction in the emissions intensity** of the agricultural sector. • Despite marginally positive economic development in the sector, GHG emissions were reduced slightly. • The lower use of nitrogen-based fertilisers and improved fertiliser processing can be traced back to policy measures.
Netherlands	• **Already low emissions intensity continues to decline.** • Lower overall emissions in the sector. The two most emissions-intensive sub-sectors have already reached their reduction targets for 2020. • Agricultural sector is responsible for a large portion of exports and overall economic performance.
France	• Structurally, France is **broadly comparable to Germany**. • A significant reduction in the GHG intensity of the agricultural sector has been achieved.
Italy	• In Italy, the agricultural sector plays a comparatively important role in the overall economy, and at almost 2.3% of GDP, accounts for a significantly higher percentage of the economy than in Germany. Although this limits comparability with the German agricultural sector, it constitutes an interesting case from the policy perspective. • **Significant emissions reductions** as well as a **reduction in the GHG intensity** of the sector were achieved.

Country	Unique aspects
UK	• With regard to the percentage of the economy and structural characteristics, the UK is **highly comparable to Germany**, and also offers interesting policy measures for reducing emissions in the agricultural sector. • In both countries, the agricultural sector accounts for approximately 0.6% of the GDP. • Both the intensity as well as overall emissions decreased in recent years.

Despite lower emissions or reduced GHG intensities in the agricultural sector, the countries in **Error! Reference source not found.** were not chosen for further analysis. The reduction effects in these countries cannot be attributed to targeted policy interventions and are therefore of little relevance in terms of transferability to Germany.

Table 14: Countries not chosen in the agricultural sector despite having achieved emissions and/or intensity reductions

Country	Unique aspects
Greece	• Emissions in the agricultural sector in Greece have indeed fallen starkly since 1990. However, this is not due to political measures and instruments, but instead primarily to lower ground-based nitrogen emissions as a result of **a decline in the use of nitrogen-based fertilisers caused by price increases**.[39] • All other significant parameters with regard to agricultural emissions (livestock population, crop production, etc.) do not show any significant changes. • In addition, the economic performance of the agricultural sector continues to be below that of 2005.
Luxembourg	• The agricultural sector in Luxembourg is very small and has little significance for the economic performance and overall emissions of the country. • Luxembourg's agricultural sector has **one of the highest emissions intensities EU-wide**. Although this intensity has decreased slightly, it continues to be at a very high level and does not follow a constant decreasing trend. • Furthermore, the overall emissions of the sector have increased slightly.
Sweden	• The slight decrease in overall emissions in the Swedish agricultural sector cannot be attributed to targeted political interventions but is instead due in large part to an **economic downturn in the agricultural sector**. • This is not a trend that was desired and induced by policies, but instead a decrease brought about by **high production costs** in Sweden as well as growing international competition, thereby making it harder for Swedish agricultural products to stay competitive in the market[40].

[39] Greek Ministry of Environment and Energy, 2018

[40] Government of Sweden, 2016

7.3 Selected instruments in the agricultural sector

Based on the selected countries in Table 13 with above-average emissions reductions in this sector, various successful policy instruments an identified for the agricultural sector. These instruments have contributed significantly to GHG reductions. Furthermore, the selected instruments contain various approaches for reducing emissions in the agricultural sector.

7.3.1 Denmark: Reduction of ammonia emissions[41]

In the Danish agricultural sector, stark reductions in emissions have been achieved since 1990. The regulation of ammonia emissions is a successful example for a policy intervention that has led to a perceptible reduction in emissions by the agricultural sector. Denmark's very low GHG intensity in agriculture is due to a combination of various measures.

Brief description	Regulatory instrument for reducing the GHG emissions in Denmark generated by the evaporation of ammonia.
The concept	The emission of ammonia stimulates nitrous oxide emissions. Reducing ammonia emissions therefore leads to a reduction in nitrous oxide emissions. The regulation of these emissions encompasses various regulations for handling liquid and solid manure to reduce the resulting emissions, including: • Optimising the handling of solid and liquid manure in stalls for cattle, pigs, and poultry. • Regulations for covering storage facilities. • Prohibition on surface dispersal and reducing the time span between the application of liquid manure and working it into the soil. • Prohibition on ammonia treatments for straw.
Effects	The strict regulation of how ammonia is handled in Denmark leads to a reduction in the use of liquid manure on fields and other processes which release ammonia. An evaluation of the Action Plan reached the conclusion that the measures implemented have led to an annual reduction of 34,000 tCO_2e in nitrous oxides. The greatest effect was achieved by the reduced exposure time of distributed liquid manure.
Transferability to Germany	If a similar instrument were to be applied in Germany, there would be a comparatively high conflict potential, as strict regulations would result in costs and the limitation of choices for stakeholders in the agricultural industry. This potential for conflict already became clear in Denmark and would have a similar effect if transferred to Germany.

[41] Sources: Eionet, no date; Danish Ministry of Energy, Utilities and Climate, 2017

7.3.2 Denmark: Action Plan for the Aquatic Environment I-III and the resulting Agreement on Green Growth[42]

Since the first Action Plan for the Aquatic Environment was agreed upon, significant emissions reductions have been achieved in the area of fertiliser use. The action plans contain a wide range of measures and have been revised based on the resulting experience. This makes them particularly interesting instruments for which interpretations about their effectiveness and further development can be made.

Brief description	During the period from 1990-2010, three "Action Plans for the Aquatic Environment" were implemented in Denmark to reduce nitrate pollution in bodies of water. These comprised a combination of economic and regulatory measures. The third Action Plan (2004–2015) gave rise to the Agreement on Green Growth for the agricultural sector.
The concept	A series of specifications and regulations were implemented via these Action Plans for the Aquatic Environment. Among other things, these aim to improve the use of liquid manure as well as implement stricter regulation of fertiliser use. The action plans served to regulate the behaviour of farmers in order to minimise the nutrient losses of the sector. In particular, specifications were laid down for the use of slurry, the better use of liquid and solid manure, as well as on minimum capacities for the storage of slurry and liquid manure. The Agreement on Green Growth lays down clear specifications on the release of nitrates and phosphor into the aquatic environment, the reduction of harmful pesticides, and support for the development of organic cultivation.
Effects	The effects achieved by the action plans include a reduction in the application of nitrogen-based fertilisers. As a result, nitrous oxide emissions were reduced by 30% during the period from 1990-2010. Because an interim evaluation of the third Action Plan for the Aquatic Environment showed that the desired effects would not be achieved, the government introduced the Agreement on Green Growth, which is an expansion of the Action Plan. The overall effect of the three Action Plans on nitrous oxide emissions is estimated at around 2.2 $MtCO_2e$ annually.
Transferability to Germany	Regulation of the use of fertilisers has already been implemented in Germany via the Fertilisers Ordinance (Düngemittelverordnung). By enhancing this regulation, additional effects could be achieved similar to those in Denmark. The greatest contribution of the Danish agricultural sector to GHG emissions comes from the breeding of dairy cattle. This sub-sector plays an important role in Germany as well, such that a high degree of effectiveness can be expected from similar measures.

[42] Sources: The Danish Environmental Protection Agency, 2009; Grantham Research Institute on Climate Change and Environment, 2017; Danish Ministry of Energy, Utilities and Climate, 2017

7.3.3 France: Measures for the promotion of bio-methane production[43]

How liquid and solid manure are handled in the future will play a significant factor in the further reduction of greenhouse gases in the agricultural sector. The sustainable production of bio-methane sector could contribute to climate protection in a positive sense.

Brief description	In France, there are multiple instruments for the promotion of agricultural bio-methane production and using it to generate electricity.
The concept	These measures consist of a combination of economic, informational, and planning instruments for the reduction of carbon dioxide, methane, and nitrous oxide emissions. In 2013, the energy performance plan for agricultural enterprises which had been in force until then was replaced by the Plan for the Competitiveness and Adaptation of Agriculture (Plan de compétitivité et d'adaptation des exploitations agricoles). It comprises various funding instruments for agricultural biogas production, including for initial investments and guaranteed prices for electricity generated using bio-methane. To supplement it, the "Nitrogen Bio-methane Energy Plan" was adopted in 2014 to implement an optimisation of the purchase price for electricity from biogas, as well as the simplification of administrative processes for the implementation of projects for anaerobic fermentation. The approach is embedded in agricultural development policy and does not focus solely on bioenergy production. It is also aims to reduce emissions from waste and solid manure processing by anaerobic fermentation and at optimising nitrogen fertiliser production, while limiting the use of food and energy crops such as corn.
Effects	Via the measures listed, increased production of renewable energy by the French agricultural sector was achieved. Furthermore, improved processing of methane and a general improvement in the handling of animal waste were also achieved. Estimated annual reductions in emissions amount to: 0.28 $MtCO_2e$ in 2013, 0.53 $MtCO_2e$ in 2015. Furthermore, expected annual future reductions are estimated at 1.38 $MtCO_2e$ in 2020, 2.23 $MtCO_2e$ in 2025, and 3.08 $MtCO_2e$ in 2030.
Transferability to Germany	The promotion of renewable energy sources enjoys a high political and societal priority in Germany. Due to the high political relevance of generating renewable energy from various sources, a comparatively high political and societal acceptance can be assumed, which would facilitate the implementation of similar measures in Germany. The main potential for transferability is in the reorientation of the sustainable development policy in the agricultural sector, although greater emphasis is placed on the processing of manure and slurry and the optimal use of minerals to reduce emissions in agriculture.

[43] Sources: French Ministry for Agriculture and Food, 2014; Ministère de l'Ecologie, du Développement durable et de l'Energie, Ministère de l'agriculture, de l'agroalimentaire et de la forêt, 2013; French Ministry for Agriculture and Food, 2014; Government of France, 2017; Direction Générale de l'Énergie et du Climat, 2017

7.3.4 Netherlands: Agrocovenant – Agreement for clean and efficient agricultural sectors[44]

In the Netherlands, ambitious targets GHG emissions reduction in the agricultural sector were agreed upon and have already been achieved. The Agrocovenant is a highly comprehensive framework agreement for this sector, and its effectiveness has already been proven.

Brief description	The "Agrocovenant" of the Dutch agricultural sector provides the climate policy framework for this sector. In 2008, the agricultural and gardening sector negotiated the agreement with the government and agreed on various targets as well as measures and instruments for reducing emissions and increasing energy efficiency. If the GHG reduction targets are not achieved, regulatory measures are taken. Similar agreements are widespread in Dutch politics.
The concept	As part of this agreement, three key targets were agreed upon: • A reduction of 3.5-4.5 MtCO2e in 2020 compared to 1990. • A reduction of 4.0 to 6.0 MtCO2e in other greenhouse gases by 2020 compared to 1990. • An annual improvement of 2% in energy efficiency during the period from 2011–2020. Pursuant to the target agreements, the agricultural industry is expected to implement cost-efficient measures to achieve them. For non-CO2 emissions, this involves the proliferation of good practices in management for the reduction of nitrogen input, for example GPS-assisted precision agriculture, measures for feeding cattle that lower methane output, as well as measures for storing liquid manure that reduce methane emissions.
Effects	Via the measures listed, increased production of renewable energy by the French agricultural sector was achieved. Furthermore, improved processing of methane and a general improvement in the handling of animal waste were also achieved. Estimated annual reductions in emissions amount to: 0.28 $MtCO_2e$ in 2013, 0.53 $MtCO_2e$ in 2015. Furthermore, expected annual future reductions are estimated at 1.38 $MtCO_2e$ in 2020, 2.23 $MtCO_2e$ in 2025, and 3.08 $MtCO_2e$ in 2030.
Transferability to Germany	The promotion of renewable energy sources enjoys a high political and societal priority in Germany. Due to the high political relevance of generating renewable energy from various sources, a comparatively high political and societal acceptance can be assumed, which would facilitate the implementation of similar measures in Germany. The main potential for transferability is in the reorientation of the sustainable development policy in the agricultural sector, although greater emphasis is placed on the processing of manure and slurry and the optimal use of minerals to reduce emissions in agriculture.

[44] Sources: Netherlands Enterprise Agency, 2018; Eionet, no date; Theune, 2017; Ministry of Economic Affairs and Climate Policy, 2017

7.3.5 Netherlands: Phosphate reduction plan – Emissions trading for phosphate emissions[45]

Emissions trading for phosphate emissions is an innovative instrument for reducing GHG emissions in the agricultural sector. It will only be possible to evaluate its effects in the coming years. Nonetheless, it is listed here as an innovate instrument with a promising approach. The prescribed reductions in phosphate are expected to achieve a GHG-reducing effect primarily by decreasing the livestock population, thereby resulting in lower methane and nitrous oxide emissions.

Brief description	In early 2018, an emissions trading system for phosphate emissions was established in the Netherlands. Because the dairy cattle population saw rapid growth after the EU milk quota was abolished, the associated emissions have increased. In order to reduce them, new regulations for phosphate emissions were introduced, as they exceeded the EU limits in 2015-2017.
The concept	The number of emissions certificates is based on the 2015 emissions level. Via the trading of certificates of phosphate emissions, emissions can be reduced cost-efficiently in situations where this can be done for the lowest cost.
Effects	Because this instrument only entered into force in January 2018, it is hardly possible to identify any effects at the moment. It is assumed that the number of dairy cows in the country will be drastically reduced.
Transferability to Germany	This instrument is an innovative approach for reducing emissions within the agricultural sector. To date, no similar instrument has been implemented in Germany. Because the dairy cattle sector is also responsible for a significant percentage of emissions in Germany's agricultural sector, similar measures may also have a impact of reducing the sector's emissions in Germany.

7.3.6 UK: Greenhouse Gas Action Plan for Agriculture in England[46]

Despite being based on voluntary measures by the agricultural industry, the Greenhouse Gas Action Plan has been able to achieve significant emissions reductions since 2011. The reductions achieved in the period from 2011 to 2016 are estimated at one million tonnes of CO2e.

Brief description	An annual emissions savings target of 3 $MtCO_2e$ by 2022 was defined for the British agricultural sector. The decentralised administrations (Wales, Scotland, Northern Ireland, and England) have each implemented their own voluntary initiatives for achieving this target. In this case, the Greenhouse Gas Action Plan of the English agricultural industry constitutes the most comprehensive catalogue of measures through which emissions reductions have already been achieved via a wide range of voluntary measures. Voluntary agreements between the agricultural industry, the government, and in some cases environmental protection organisations have a long history in England. The Action Plan is based on these collaborations.

[45] Sources: Government of the Netherlands, 2017; Government of the Netherlands, 2018

[46] Source: Campaign for the Farmed Environment, 2015

The concept	The Greenhouse Gas Action Plan is a voluntary initiative by 14 organisations in the agricultural industry. The Action Plan was compiled and is being implemented by these organisations. Via established communication channels, information is disseminated about modern production and cultivation methods that can increase operational efficiency and competitiveness while simultaneously reducing emissions. The measures contained in the Action Plan encompass all areas of agricultural activities.
Effects	The effects achieved by the Action Plan include increased awareness of and attention paid to GHG effects among stakeholders in the agricultural sector. By 2016, the activities of the Action Plan are estimated to have achieved an annual reduction of one million tonnes of CO_2e. The implementation of a large number of individual measures in agricultural enterprises also leads to an increase in efficiency and cost reductions for resources such as fertiliser. Overall, this results in a more widespread use of modern production methods.
Transferability to Germany	The agricultural sectors in Germany and England are highly comparable, which increases the transferability of the Greenhouse Gas Action Plan to the german context. A voluntary agreement would also enjoy a higher level of acceptance among the stakeholders of the agricultural industry than a regulatory instrument, as the resulting costs would be comparatively low and usually preferred over economic or regulatory intervention. One key difference when compared to Germany lies in the fact that the UK has significantly stricter statutory regulations and regulatory limits regarding climate protection in the agricultural sector, as statutory regulations for national emissions reduction targets are in place in the UK.

7.4 Summary

The most widespread type of policy instruments for reducing GHG emissions in the agricultural sector are action plans and voluntary agreements with the agricultural industry. Tighter regulation of various processes in agricultural enterprises is also frequently implemented in this sector. Detailed factsheets were created for the following instruments as their transferability to Germany was assessed as being high:

- Denmark: Action Plans for the Aquatic Environment and Agreement on Green Growth
- Denmark: Reduction of ammonia emissions
- France: Measures for the promotion of bio-methane production
- UK: Greenhouse Gas Action Plan for Agriculture in England

It would be conceivable to transfer similar instruments from section 7.3 to Germany, but for the detailed factsheets only instruments were selected that could give new impetus and go beyond the existing instrument mix in Germany.

8 Detailed assessment of the waste sector

8.1 Description of the waste sectors

Around 50% of waste generated in the EU is deposited in landfills. The greatest contribution to methane gas avoidance is made by a reduction in the annual quantities deposited in landfills as well as the capturing and use of landfill gases to generate energy. Already in the year 2014, almost no municipal waste was deposited in landfills in Austria, Belgium, Denmark, Germany, the Netherlands, Norway, Sweden, and Switzerland (EEA, 2016).

Using residual waste to supply energy contributes to climate protection if doing so replaces fossil fuels in energy generation. In this case, however, the replacement effect may fall under the ETS, i.e. emissions reductions due to successful waste policies for climate protection may have an impact outside the ESD sector. Recycling, too, can result in global savings on CO_2 emissions via the reduced use of primary energy (UBA, Klimaschutz in der Abfallwirtschaft [Climate protection in waste management], 2015). But because recycling requires energy, it can increase emissions in the EU if it primarily replaces imports.

Due to the historically widespread prevalence of emissions from deposition in landfills as well as methane gas emissions (**Error! Reference source not found.**), successful reduction policies in the waste sector have focused above all on the reduction of methane gas emissions via reducing the use of landfills. With the now almost complete abolition of the use of landfills in leading countries, additional policies are required for further emission reductions: For one, the use of waste to generate energy can be optimised — via better waste separation (better usability for energy generation) and by promoting combined heat and power generation as the most efficient use of energy. Furthermore, avoiding waste can reduce emissions, while the energy emissions associated with recycling mostly fall under the EU ETS.

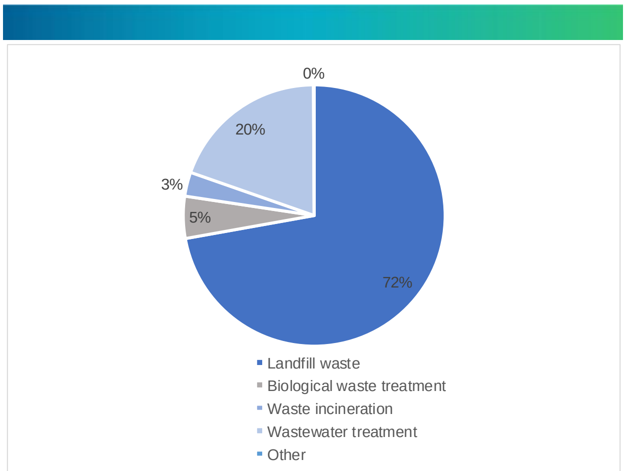

Figure 8: Emissions from waste by source sector (2015)

8.2 Sector-specific developments

8.2.1 Overview of sector-specific developments

Across Europe, waste emissions fell by 31% between 2005 and 2015 (Eurostat, 2017). In 2015, the waste sector only accounted for 1.2% of total emissions in Germany. This means that greenhouse gas emissions fell by over 70% between 1990 and 2015, which corresponds to the highest relative reduction of the various sectors (UBA, Treibhausgas-Emissionen in Deutschland [Greenhouse gas emissions in Germany], 2017). As shown in the following table, this is a sustained trend. Between 2005 and 2015, emissions in the German waste sector decreased by 47%. Hence, Germany plays a leading role in the waste sector. However, there is a huge discrepancy between the trend in leading countries and the EU average. Because emissions during energy generation are attributed to the energy sector, waste emissions and the observed reductions consist largely of methane emissions, which are released during the uncontrolled decomposition of waste in landfills.

The waste sector differs from the other sectors in that no good is supplied, and hence trends in **absolute emissions** are generally more meaningful than in other sectors (see below). Other available indicators for this sector include the **emissions intensity per tonne of waste** (I.pTonne4-14). It expresses the amount of emissions generated per tonne of waste and is therefore an indicator of how well emissions are avoided in various countries through energy generation[47] or recycling. However, it refers to the overall quantity of waste generated, and hence only allows limited conclusions to be drawn about the handling of emissions-intensive organic waste.[48] Furthermore, the emissions intensity of the sector, measured by the **added value of the waste industry** (I.NACE.A8-15), can also be used as an indicator.

[47] When used for energy generation, emissions are released, but they are attributed to the energy sector. Additionally, it is generally assumed that these emissions replace other (fossil) emissions.

[48] Hence, a period of strong activity in the construction industry, for example, could influence these statistics if construction waste were to make up a large portion of the weight of the waste, but are not responsible for emissions.

Table 15: Emissions trends and intensities in the waste sector

Green: Emissions and intensity trends in the selected countries; bold: the five which achieved the greatest reductions.

Waste[49]	EU-28	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK	NO	CH
Emissions trend																															
Emissions	-31%	-48%	-22%	28%	-10%	**-47%**	-37%	-26%	-6%	-1%	-20%	49%	-24%	6%	-3%	-30%	-17%	-13%	-18%	-46%	-41%	-16%	-17%	3%	-34%	12%	-24%	-47%	-63%	-18%	-12%
Relevant intensities																															
Intensity per tonne of waste (*I.pTonne*$_{4-14}$)	-29%	-52%	-17%	58%	-43%	-51%	-40%	-6%	**-54%**	49%	-23%	171%	-29%	17%	-49%	-18%	1%	31%	53%	-64%	-44%	-34%	57%	117%	-23%	31%	-48%	-71%	-55%	-47%	N/A
Intensity of the waste industry (*I.NACE.A*$_{8-15}$)	-26%	-41%	-26%	64%	25%	**-50%**	-32%	-9%	63%	14%	-8%	-3%	17%	-33%	-12%	-47%	-16%	-3%	N/A	-8%	-39%	N/A	0%	12%	-13%	-14%	-20%	-46%	-57%	-12%	N/A

[49] Emissions: Eurostat [env_air_gge], CRF 5 overall. I.pTonne: Development in the intensity of emissions per tonne of waste generated in the period from 2004 to 2014 (comparison with [env_wasgen]). I.NACE.A: [env_ac_aeint_r2], NACE E37-E39).

In almost all EU-28 Member States, a reduction can be observed between 2005 and 2015 in **absolute GHG emissions** generated by waste management activities (**Error! Reference source not found.**). In the UK, this GHG reduction had a value of up to 63%. In Germany and the selected countries, the emissions reduction was between 40% and 50%, which clearly shows that emissions reduction was highly successful compared to other sectors. In these leading countries, the **emissions intensity** per tonne of waste also fell dramatically, which points to the fact that the reductions observed are systematic policy-induced trends instead of random fluctuations. Despite the largely positive trend, waste emissions increased in a number of Member States, e.g. in Croatia (HR) by almost 50%, and in the Czech Republic by almost 30%.

8.2.2 Selection of country-sector combinations

Compared to other sectors where goods or services are provided, the waste sector is characterised by the fact that the avoidance of waste is desirable under all circumstances. Hence, absolute emissions reductions are a better indicator in this sector than in other sectors. Based on this criterion, Belgium, Austria, the Netherlands, Sweden, and the United Kingdom were selected for the analysis. Additionally, as countries with an ambitious environmental policy and which were less impacted by the economic crisis, they have a high comparability to Germany.

Table 16: Country-sector combinations examined in the waste sector

Country	Unique aspects
Belgium	• Emissions reduction in waste sector comparable to Germany
Netherlands	• Emissions reduction in waste sector comparable to Germany
Austria	• Emissions reduction in waste sector comparable to Germany
Sweden	• Emissions reduction in waste sector comparable to Germany • Environmental consciousness well above average • Significant expansion of district heating in combination with waste-to-energy
UK	• Substantial emissions reduction in waste sector

When performing the selection, instruments for reducing landfill waste as well as for recycling were also not considered due to the following reasons:

- Landfill taxes or other measures for reducing landfill waste were, when utilised, highly successful, but not very helpful with regard to additional emissions reductions in Germany, as the country's landfilling rate is already below 5%. Hence, the greatest savings potential lies in the nature of waste processing outside of landfills.
- Recycling and recycling policies are ambivalent with regard to European emissions reductions, as the emissions saved via greater material efficiency are balanced by the energy emissions associated with recycling. For goods that are mainly imported, e.g. electrical products, a discrepancy may result between the life cycle perspective (recycling lowers global emissions) and a perspective focused on

national or European emissions reductions (recycling lowers European emissions only if energy emissions are lower than the manufacturing emissions avoided). Furthermore, it is unclear as to what degree recycling lowers ESD emissions, which depends not only on the balance of trade (see above) but also the coverage of manufacturing emissions in the ETS. Due to this complexity, recycling policies are not included in our proposals.

Furthermore, it should be noted that the emissions from using waste to generate energy, which is the most important form of waste processing apart from recycling, count towards the energy sector. In this case, depending on the size of the installation, emissions saved from the replacement of fossil energy carriers fall under the EU ETS. Hence, policies which optimise the use of waste to generate energy — e.g. by promoting combined heat and power generation — may exert their emissions-reducing effects outside the ESD sector. Despite this, they are considered here.

8.3 Selected instruments in the waste sector

The instruments selected represent two ends of a spectrum; on the one hand a successful example for conventional waste policy from one of the countries with the greatest reductions (UK landfill tax), and on the other as an innovative instrument for turning the waste sector into an emissions-neutral to emissions-negative sector (waste-to-energy with CCS in Norway). Because potential for emissions reductions via additional landfill avoidance is limited in the German waste sector, the nature of how waste is used for energy generation is of great interest for emissions linked to waste. In this case, carbon capture has the potential for reducing emissions even further.

8.3.1 Norway: Waste-to-energy with carbon capture and storage (CCS) in Oslo[50]

This policy has the potential of making waste combustion in Oslo emissions-neutral or even emissions-negative.

Brief description	The policy envisioned in Oslo, which is also supported by the Norwegian government, consists of combining the use of waste to generate energy with carbon capture and storage (CCS). A successful test phase for this project has already been concluded. This process would result in negative emissions. Even though it has not yet been implemented, it is an important case study due to the goal of complete emissions neutrality.
The concept	Via the subsidies and/or regulations planned for in this policy, CCS would be introduced for waste-to-energy installations, such that the combustion of waste for energy would result in negative emissions for biogenic materials and would be emissions-neutral for other materials.
Effects	In addition to the emissions avoided via carbon capture, technological learning effects are also to be expected here, which would improve the cost efficiency and application of CCS and could therefore contribute to european and global emissions reductions.

[50] Source: Stuen, 2016

Transferability to Germany	CCS is controversial in Germany and hence potentially difficult to enforce. At the same time, the benefits of the technology would be greater in Germany than in Norway, as comparatively less clean energy is available.

8.3.2 UK: Landfill tax[51]

In the UK, the landfill tax has contributed significantly to reducing the landfilling rate — as well as the associated methane emissions.

Brief description	Introduced in the UK in 1996, the landfill tax is a price instrument. It is a tax that increases over time and is levied on a per-tonne basis for biodegradable landfill waste. Between 2007 and 2014, the tax rate was increased by 300%, from approx. GBP 25 to GBP 80 per tonne of landfill waste. This massive increase within a short period of time facilitates the identification of the policy's effects, as other factors do not change as rapidly.
The concept	Equivalent to a CO_2 tax, the landfill tax provides an incentive to not only directly avoid waste (higher material efficiency) but also dispose of waste in a different manner (e.g. use it to generate energy). By changing relative prices, the tax incentivises alternatives to landfills. Because the tax is levied on quantities of waste, it does not incentivise the reduction of emissions within landfills (unlike e.g. a CO_2 tax, which provides incentives for more efficient coal combustion), rather the landfill tax (Elliot, 2016-2017) provides incentives for avoiding waste and using it to generate energy or recycling it.
Effects	The landfilling rate has fallen dramatically, such that emissions in the waste sector have decreased by over 60%. The price escalation of the tax in the period examined indicates that it is probable that this policy instrument had a strong influence on this trend.
Transferability to Germany	In general, the concept is transferable to Germany, and there is political acceptance for it. However, because Germany has also achieved high emissions reductions in the waste sector and the landfilling rate is already low, there is limited overall potential for achieving additional emissions reductions.

8.4 Summary

The most widespread type of policy instruments for reducing GHG emissions in the waste sector are policies for reducing the landfilling rate. In the leading countries, among them Germany, the disposal of waste in landfills has become marginal, such that the potential of these policies for achieving additional emissions reductions is limited. Recycling policies lead to global emissions reductions, but do not necessarily have an effect on emissions in the ESD sector. The emissions resulting from the use of waste for energy generation as well as the assumed savings in comparison to the combustion of fossil fuels are attributed to the energy sector. Hence, the options for additional emissions reductions in the waste sector, other than waste avoidance policies, are limited for Germany.

[51] Sources: Gov.uk, no date; Elliot, 2016-2017

Due to the limited options for reduction as well as the limited possible learning experiences for Germany, the applicability of measures in the waste sector to Germany is assessed as being low.

9 Summary

The federal government intends to adopt the first programme of measures for the 2050 Climate Action Plan by the end of 2018. It will lay down specific measures for achieving the 2030 targets defined in the Climate Action Plan for the individual sectors. This overview paper contributes to the identification of suitable measures for additional emissions reductions by examining successful climate protection efforts and/or instruments in non-ETS sectors (transport, buildings, industry, agriculture, and waste) from other EU Member States, Norway, and Switzerland.

These sectors are responsible for around 60% of EU-wide GHG emissions. In most European countries, the transport sector is the non-ETS sector with the most GHG emissions. Around one third of ESD emissions EU-wide come from this sector. The building sector is responsible for a quarter of EU-wide emissions covered by the Effort Sharing Decision. The agricultural sector and the areas of the industrial sector not covered by the ETS constitute additional important sources of emissions.

From an EU-wide standpoint, it was possible to save emissions in all ESD sectors between 2005 and 2015, but in numerous Member States the scope of the emissions reductions could be increased to achieve national, European, and international climate protection goals.

In order to contribute to this, the respective sub-chapters x.3 of chapters 3-7 presented an overview of particularly effective climate protection instruments. Instruments were selected from the various countries in those national sectors that exhibited a reduction in absolute emissions, but also taking into account other relevant indicators, in particular sector-specific emissions intensities.

Subsequently, instruments were identified for each sector that were assessed as having a high level of transferability to Germany. For the policy measures summarised in **Error! Reference source not found.** detailed factsheets have been created.

Table 17: Climate protection instruments with a high level of transferability to Germany

Sector	Country	Instrument
Cross-sector	France	Energy Transition for Green Growth Act
	Sweden	Climate Act
	UK	Climate Change Act
Transport	France	Bonus-malus system for vehicles
	Norway	Incentives for electric vehicles
	Sweden	Taxation of company vehicles
	Switzerland	Shifting goods traffic onto the rails

Sector	Country	Instrument
Buildings	Denmark	Energy Performance Certificate Database
	France	Tax credit for energy transition
	Latvia	Baltic Energy Efficiency Facility (LABEEF)
	Sweden	Innovation clusters
	Slovakia	Sustainable Energy Financing Facility (SlovSEFF)
	Czech Republic	New Green in Savings programme (cross-sector, focus on buildings)
Industry	Belgium	Tax deduction for energy savings
	Denmark	Energy efficiency commitments (cross-sector, focus on industry)
	Sweden	CO_2 tax (cross-sector, focus on industry)
	UK	Climate Change Agreements
Agriculture	Denmark	Action Plans for the Aquatic Environment and Agreement on Green Growth
	Denmark	Reduction of ammonia emissions
	France	Measures for the promotion of bio-methane production
	UK	Greenhouse Gas Action Plan for Agriculture in England

10 Sources

ADEME. (2009). *Evaluation of the economic and ecological effects of the French 'bonus malus' for new cars.* Retrieved from http://www.odyssee-mure.eu/private/workshop-papers/paris/session1_bonus_malus.pdf

Andersson, J. (2017, März). Cars, carbon taxes and CO_2 emissions. *Centre for Climate Change Economics and Policy Working Paper No 238*.

Austrian Government. (2017). *Seventh National Communication.* Retrieved from https://unfccc.int/sites/default/files/resource/69823015_Austria-NC7-1-AT_NC7.pdf

BAFU. (2017). *Bundesrat legt die nächste Etappe der Schweizer Klimapolitik fest.* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/mitteilungen.msg-id-69071.html

BAFU. (2017). *Gebäude.* Retrieved from https://www.bafu.admin.ch/bafu/de/home/themen/klima/fachinformationen/klimapolitik/gebaeude.html

BAV. (2018). *Nacht- und Sonntagsfahrverbot.* Retrieved from https://www.bav.admin.ch/bav/de/home/themen/alphabetische-themenliste/landverkehrsabkommen/die-inhalte-des-landverkehrabkommens0/nacht--und-sonntagsfahrverbot.html

BAV. (2018). *Verlagerung des Güterverkehrs durch die Alpen.* Retrieved from https://www.bav.admin.ch/bav/de/home/themen/alphabetische-themenliste/verlagerung.html

BAV. (n.d.). *Neue Rahmenbedingungen für Bahngüterverkehr treten Anfang Juli in Kraft.* Retrieved from https://www.bav.admin.ch/bav/de/home/aktuell/medienmitteilungen.msg-id-61855.html

Bohlin, F. (1998). The Swedish Carbon Dioxide Tax: Effects on Biofuel Use and Carbon Dioxide Emissions. *Biomass and Bioenergy*, pp. 283-291.

BMU (2018). Klimaschutzbericht 2017 - Zum Aktionsprogramm Klimaschutz 2020 der Bundesregierung.

BPIE. (2014). *Energy Performance Certificates Databases: Current status of implementation across Europe.*

Brännlund, R., Lundgren, T., & and Marklund, P.-P. (2014). Carbon intensity in production and the effects of climate policy - Evidence from Swedish industry. *Energy Policy*, pp. 844-857.

Bundesrat. (2016). *Wirksamkeit der Finanzhilfen zur Verminderung der CO_2-Emissionen bei Gebäuden gemäss Artikel 34 CO_2-Gesetz.* Retrieved from https://www.bafu.admin.ch/dam/bafu/de/dokumente/klima/fachinfo-daten/wirksamkeit_der_finanzhilfenzurverminderungderco2-emissionenbeig.pdf.download.pdf/wirksamkeit_der_finanzhilfenzurverminderungderco2-emissionenbeig.pdf

Campaign for Better Transport. (n.d.). *Local Sustainable Transport Fund.* Retrieved from https://www.bettertransport.org.uk/local-sustainable-transport-fund

Campaign for the Farmed Environment. (2015). *Greenhouse Gas Action Plan*. Retrieved from Campaign for the Farmed Environment: http://www.cfeonline.org.uk/home/about-us/greenhouse-gas-action-plan/

Council of Ministers (2017): *Bilan de l'application de la loi de transition énergétique pour la croissance verte et stratégies d'application.* https://www.gouvernement.fr/conseil-des-ministres/2017-04-19/bilan-de-l-application-de-la-loi-de-transition-energetique-p

Danish Energy Agency. (2017). *The Danish Energy Model - Innovative, efficient and sustainable.* Retrieved from https://ens.dk/sites/ens.dk/files/Globalcooperation/the_danish_energy_model.pdf

Danish Ministry of Energy, Utilities and Climate. (2017). *Denmark's Seventh National Communication on Climate Change.* Retrieved from https://unfccc.int/sites/default/files/resource/8057126_Denmark-NC7-BR3-2-NC7-DNK-Denmarks-NC7-and-BR3_1January2018-12MB.pdf

Danish Ministry of Energy, Utilities and Climate. (2017, December). *Denmark's Seventh National Communication and Third Biennial Report.* Retrieved from UNFCCC: https://unfccc.int/sites/default/files/resource/8057126_Denmark-NC7-BR3-2-NC7-DNK-Denmarks-NC7-and-BR3_1January2018-12MB.pdf

Deloitte. (2017). *Taxation and Investment in Belgium.* Retrieved from https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Tax/dttl-tax-belgiumguide-2017.pdf

Department for Transport. (2017). *Impact of the Local Sustainable Transport Fund - Summary Report.* Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/648822/local-sustainable-transport-fund-impact-summary-report.pdf

Department for Transport. (2017). *Local Sustainable Transport Fund 'What Works' report - Summary .* Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584470/lstf-what-works-cover-note.pdf

Ecofys. (2017). *Research for TRAN Committee - Charging Infrastructure for Electric Road Vehicles.*

Ecofys et al. (2017). *Internationale best-practice-Instrumente für eine erfolgreiche Energiewende im Verkehr.*

EEA. (2016). *Less household waste going to landfill in Europe*. Retrieved from European Environmental Agency: https://www.eea.europa.eu/highlights/less-household-waste-going-to

EEA. (2017). *Annual European Union greenhouse gas inventory 1990-2015 and inventory report 2017.* Retrieved from https://www.eea.europa.eu/publications/european-union-greenhouse-gas-inventory-2017

EEA. (2017). *Tracking progress towards Europe's climate and energy targets.* Retrieved from https://www.eea.europa.eu/publications/trends-and-projections-in-europe-2017

EEA. (2018): *Eionet - Policies and Measures (PaMs),* Czech Republic.

Eionet. (n.d.). *1. G2(former TD-1a): Energy taxes*. Retrieved from Eionet - Policies and Measures (PaMs), Denmark: http://cdr.eionet.europa.eu/Converters/run_conversion?file=/dk/eu/mmr/art04-13-14_lcds_pams_projections/pams/envwaqrjw/DK_adjusted.xml&conv=524&source=remote#pam45

Eionet. (n.d.). *19. Covenant Clean & Efficient Agro-sectors*. Retrieved from Eionet - Policies and Measures (PaMs), Netherlands: http://cdr.eionet.europa.eu/Converters/run_conversion?file=/nl/eu/mmr/art04-13-14_lcds_pams_projections/pams/envwau0kg/NL_adjusted.xml&conv=524&source=remote#pam19

Elliot, T. (2016-2017). *Landfill Tax in the United Kingdom.* Retrieved from Eunomia, IEEP: https://ieep.eu/uploads/articles/attachments/e48ad1c2-dfe4-42a9-b51c-8fa8f6c30b1e/UK%20Landfill%20Tax%20final.pdf?v=63680923242

Energy Efficiency Watch. (2013). *Energy Efficiency in Europe - Findings from the Energy Efficiency Watch Project in Europe.* Retrieved from http://www.energy-efficiency-watch.org/fileadmin/eew_documents/Documents/EEW2/Sweden.pdf

Environment Agency. (2015). *Climate Change Agreements: Biennial Progress Report 2014 and 2014.* Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/479679/Biennial_progress_report_2013_and_2014.pdf

Erneuerbare Energien. (2015). *Steuerliche Absetzbarkeit abgesagt.* Retrieved from https://www.erneuerbareenergien.de/steuerliche-absetzbarkeit-abgesagt/150/436/85935/

ESRI. (2013). *The value of domestic building energy efficiency – evidence from Ireland.* Retrieved from https://www.esri.ie/pubs/JACB201377.pdf

Euroheat & Power. (2017). *District Energy in Sweden.*

European Bank for Reconstruction and Development (EBRD). (2014). Operation Evaluation. Slovak sustainable energy finance facility I & II. https://www.ebrd.com/downloads/about/evaluation/1405SEFF.pdf.

European Bank for Reconstruction and Development (EBRD). (2015). EBRD strengthens support for sustainable energy in Slovak Republic. https://www.ebrd.com/news/2015/ebrd-strengthens-support-for-sustainable-energy-in-slovak-republic.html.

European Commission. (2017). *Effort sharing 2021-2030: targets and flexibilities.* Retrieved from https://ec.europa.eu/clima/policies/effort/proposal_en

European Commission. (2017). *National Energy Efficiency Action Plan and Annual Reports.* Retrieved from https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans

European Commission. (2018). *Effort sharing: Member States' emission targets*. Retrieved from https://ec.europa.eu/clima/policies/effort_en#tab-0-3

Eurostat. (2017). *Greenhouse gas emission statistics - emission inventories*. Retrieved from Eurostat: http://ec.europa.eu/eurostat/statistics-explained/index.php/Greenhouse_gas_emission_statistics

EVBOX. (2017). *3 Electric car incentives you need to know in Europe.* Retrieved from https://blog.evbox.com/electric-car-incentives

Französische Botschaft in Deutschland. (2017). *Klimaschutz: Das französische Bonus-Malus-System beim Autokauf.* Retrieved from https://de.ambafrance.org/Klimaschutz-Das-franzosische-Bonus-Malus-System-beim-Autokauf

French Ministry for Agriculture and Food. (2014, June 3). *Le Plan Pour la Compétitivité et l'Adaptation des Exploitations Agricoles 2014/2020.* Retrieved from agriculture.gouv.fr: http://agriculture.gouv.fr/sites/minagri/files/plan_pour_la_competitivite_et_ladaptation.pdf

Gov.uk. (n.d.). *Environmental taxes, reliefs and schemes for businesses*. Retrieved from Gov.uk: https://www.gov.uk/green-taxes-and-reliefs/landfill-tax

Government of France. (2017, December). *Seventh National Communication of France.* Retrieved from UNFCCC: https://unfccc.int/sites/default/files/resource/901835_France-NC7-2-NC%20-%20FRANCE%20%20-%20EN%20-VF15022018.pdf

Government of Slovenia. (2018). *Slovenia NIR 2018.* Retrieved from https://unfccc.int/documents/65714

Government of Sweden. (2016). *A National Food Strategy for Sweden.* Retrieved from https://www.government.se/498282/contentassets/16ef73aaa6f74faab86ade5ef239b659/livsmedelsstrategin_kortversion_eng.pdf

Government of the Netherlands. (2017). *European Commission gives green light for dairy cattle phosphate system*. Retrieved from Government of the Netherlands: https://www.government.nl/latest/news/2017/12/19/european-commission-gives-green-light-for-dairy-cattle-phosphate-system

Government of the Netherlands. (2018). *7th National Communication.* Retrieved from http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/seventh_netherlands_national_communication_under_the_unfccc.pdf

Grantham Research Institute on Climate Change and the Environment (2015): *Law no. 2015-992 on Energy Transition for Green Growth (Energy Transition Law).* The London School of Economics and Political Sciences. http://www.lse.ac.uk/GranthamInstitute/law/law-no-2015-992-on-energy-transition-for-green-growth-energy-transition-law/

Grantham Research Institute on Climate Change and Environment. (2017, August 22). *Denmark*. Retrieved from lse.ac.uk/GranthamInstitute: http://www.lse.ac.uk/GranthamInstitute/country-profiles/denmark/

Greek Ministry of Environment and Energy. (2018). *7th National Communication.* Retrieved from http://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/48032915_greece-nc7-br3-1-nc7_greece.pdf

Housing Europe. (2018). *Decarbonisation of the building stock: a two-front battle.* Retrieved from http://www.housingeurope.eu/resource-1096/decarbonisation-of-the-building-stock-a-two-front-battle

ICEDD. (2017). *Evaluation of Emission Reductions.* Retrieved from http://www.climat.be/files/3315/0537/7367/Evaluation_federal_PAMs_July_2017_corr.pdf

IEA. (2013). *Tax Benefits for Energy-Efficient Cars (Belasting van personenautos en motorrijwielen - BPM).* Retrieved from https://www.iea.org/policiesandmeasures/pams/netherlands/name-22923-en.php

IEA. (2014). *Environmental and traffic safety requirements for government vehicles and trips.* Retrieved from https://www.iea.org/policiesandmeasures/pams/sweden/name-24937-en.php?s=dHlwZT1jYyZzdGF0dXM9T2s,&return=PG5hdiBpZD0iYnJlYWRjcnVtYiI-PGEgaHJlZj0iLyI-SG9tZTwvYT4gJnJhcXVvOyA8YSBocmVmPSIvcG9saWNpZXNhbmRtZWFzdXJlcy8iPlBvbGljaWVzIGFuZCBNZWFzdXJlczwvYT4gJnJhcXV

IEA. (2015). *Bonus-Malus: vehicle CO_2 bonus and penalty system.* Retrieved from https://www.iea.org/policiesandmeasures/pams/france/name-24223-en.php?s=dHlwZT1lZSZzdGF0dXM9T2s,&return=PG5hdiBpZD0iYnJlYWRjcnVtYiI-PGEgaHJlZj0iLyI-SG9tZTwvYT4gJnJhcXVvOyA8YSBocmVmPSIvcG9saWNpZXNhbmRtZWFzdXJlcy8iPlBvbGljaWVzIGFuZCBNZWFzdXJlczwvYT4gJnJhcXV

IEA. (2016). *Tax credit for energy transition (CITE).* Retrieved from https://www.iea.org/policiesandmeasures/pams/france/name-22732-en.php?s=dHlwZT1yZSZzdGF0dXM9T2s,&return=PG5hdiBpZD0iYnJlYWRjcnVtYiI-PGEgaHJlZj0iLyI-SG9tZTwvYT4gJnJhcXVvOyA8YSBocmVmPSIvcG9saWNpZXNhbmRtZWFzdXJlcy8iPlBvbGljaWVzIGFuZCBNZWFzdXJlczwvYT4gJnJhcXV

IEA. (2017). *Energy Audits for Companies.* Retrieved from https://www.iea.org/policiesandmeasures/pams/sweden/name-24733-en.php

KBA. (2017). *Jahresbilanz der Neuzulassungen 2017.* Retrieved from https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/n_jahresbilanz.html

Loga, T. D. (2012). *Use of Energy Certificate Databases as Data Source for National Building Typologies: TABULA Thematic Report N° 1. .* Darmstadt.

Ministère de l'Ecologie, du Développement durable et de l'Energie, Ministère de l'agriculture, de l'agroalimentaire et de la forêt. (2013). *Le Plan Energie Méthanisation Autonomie Azote (EMAA).* Retrieved from agriculture.gouv.fr: http://agriculture.gouv.fr/file/le-plan-energie-methanisation-autonomie-azote-emaa

Ministry for the Economy, Industry and Employment. (n.d.). *How the French car industry is facing globalisation.* Retrieved from https://www.tresor.economie.gouv.fr/Ressources/file/326998

Ministry of Economic Affairs and Climate Policy. (2017, December 29). *Seventh Netherlands National Communication under the United Nations Framework Convention on Climate Change.* Retrieved from UNFCCC: http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/seventh_netherlands_national_communication_under_the_unfccc.pdf

MURE. (2008). *SK 9 Operational programme "Competitiveness and Economic Growth" – priority line "Energy".* Retrieved from http://www.measures-odyssee-mure.eu/public/mure_pdf/industry/SK9.PDF

MURE. (2018). *Title of the measure: CZ25: New Green in Savings Programme 2014-2020.* OdysseeMure/Enviros. Retrieved September 18, 2018, from http://www.measures-odysseemure.eu/public/mure_pdf/household/CZ25.PDF and http://www.measures-odyssee-mure.eu/topics-energyefficiency-policy.asp

Netherlands Enterprise Agency. (2018). *Schone en zuinige agrosectoren*. Retrieved from rvo.nl: https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/groene-economie/agrosectoren

Norsk Ebil Forening. (2018). *Norwegian EV policy.* Retrieved from https://elbil.no/english/norwegian-ev-policy/

Norwegian Government. (2017). *Norway will reach the climate targets by 2030.* Retrieved from https://www.regjeringen.no/no/aktuelt/slik-skal-norge-na-klimamalene-for-2030/id2557549/

Norwegian Ministry of Climate and Environment. (2017). *Norway's electric vehicle policies.* Retrieved from http://www.mhsr.sk/uploads/files/ocrMJ55J.pdf

Odyssee Mure. (2014). *Value of fringe benefits for company cars.* Retrieved from http://www.measures-odyssee-mure.eu/public/mure_pdf/transport/SWE13.PDF

Odyssee-Mure. (2017). *Technology Procurement Groups.* Retrieved from http://www.odyssee-mure.eu/publications/policy-brief/technology-procurement-groups-networks.html

Odyssee-Mure. (2018). *Czech Republic Profile.* Retrieved September 20, 2018, from http://www.odysseemure.eu/publications/efficiency-trends-policies-profiles/czech-republic.html.

Österreichischer Biomasse-Verband. (2017). *2 Millionen Haushalte in Österreich heizen mit Holz.* Retrieved from http://www.biomasseverband.at/presse/presseaussendungen/pressematerialien-2017/2-millionen-haushalte-in-oesterreich-heizen-mit-holz/

RAI Vereniging. (n.d.). *Automotive taxation in the Netherlands.* Retrieved from http://www.ft.dk/samling/20131/almdel/sau/bilag/11/1286965.pdf

Ricardo Energy & Environment. (2017). *Climate Change Agreements.* Retrieved from http://www.measures-odyssee-mure.eu/public/mure_pdf/industry/UK6.PDF

RVO. (2016). *Electric transport in the Netherlands.* Retrieved from https://www.rvo.nl/sites/default/files/2017/04/Highlights-2016-Electric-transport-in-the-Netherlands-RVO.nl_.pdf

Scharin, & Wallström. (2018). *The Swedish CO_2 tax - an overview.*

SEAI. (2015). *Energy Efficiency trends and policies in Ireland.* Retrieved from http://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-ireland.pdf

SEAI. (2017). *Building Energy Rating Certificate (BER).* Retrieved from https://www.seai.ie/energy-ratings/building-energy-rating-ber/

SEF. (2018). *Presentation by and Mail communication with Jakub Hrbek on the New Green in Savings Programme (SEF).* Programme of the Ministry of Environment (MoE) which is run by the State Environmental Fund of the Czech Republic (SEF). Poland, 2018

Sénat. (2017). *Projet de loi de finances pour 2018 : Fiscalité de la transition écologique.* Retrieved from http://www.senat.fr/rap/a17-113-1/a17-113-11.html

SFZP. (2018). About the New Green in Savings Programme. Retrieved September 14, 2018, from https://www.novazelenausporam.cz/about-the-new-green-savings-programme/.

Slovak Ministry of Economy. (2009). *Operational programme Competitiveness and Economic Growth.* Retrieved from http://www.rra-nitra.sk/wp-content/uploads/2009/07/operational-programme-competitiveness-and-development.pdf

SlovSEFF. (2018). Renewable Energy. http://www.slovseff.eu/index.php/en/eligible-projects/renewable-energy#.

Stuen, J. (2016, June 16). *Carbonnegative waste-to-energy in Oslo*. Retrieved from CEWEP: http://www.cewep.eu/wp-content/uploads/2017/10/J.-Stuen-CCS-Pilot-Project-in-Oslo.pdf

Swedish Energy Agency. (2015). *Energy Efficiency trends and policies in Sweden.* Retrieved from http://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-sweden.pdf

Swedish Government. (2017). *Sweden's Seventh National Communication on Climate Change.* Retrieved from https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/6950713_sweden-nc7-1-swe_nc7_20171222.pdf

The Danish Environmental Protection Agency. (2009, June 16). *Agreement on Green Growth.* Retrieved from The Danish Environmental Protection Agency: http://eng.mst.dk/media/mst/69152/Danish%20Agreement%20on%20Green%20Growth_300909.pdf

Theune, E. (2017, January 26). *Dutch Agriculture and the Climate.* Retrieved from Holanda.es: https://www.holanda.es/media/109236/1)%20dutch%20ag%20and%20climate%20mad_theune.pdf

Thomsen, K. E. (2014). *.Implementation of the EPBD in Denmark: Status in December 2014.*

UBA. (2015). *Klimaschutz in der Abfallwirtschaft*. Retrieved from Umweltbundesamt: https://www.umweltbundesamt.de/themen/abfall-ressourcen/abfallwirtschaft/klimaschutz-in-der-abfallwirtschaft

UBA. (2016). *Emissionsquellen.* Retrieved from https://www.umweltbundesamt.de/themen/klima-energie/klimaschutz-energiepolitik-in-deutschland/treibhausgas-emissionen/emissionsquellen#textpart-5

UBA. (2017). *Beitrag der Landwirtschaft zu den Treibhausgas-Emissionen.* Retrieved from https://www.umweltbundesamt.de/daten/land-forstwirtschaft/beitrag-der-landwirtschaft-zu-den-treibhausgas#textpart-1

UBA. (2017). *Treibhausgas-Emissionen in Deutschland*. Retrieved from Umweltbundesamt: https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland#textpart-1

UK Government. (n.d.). *The UK's Sixth National Communication and First Biennial Report under the UNFCCC.* Retrieved from http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/uk_6nc_and_br1_2013_final_web-access%5B1%5D.pdf

Umweltbundesamt. (2016). *Klimaschutzbericht 2016.* Retrieved from http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0582.pdf

UNFCCC. (2017). *The Seventh National Communication of France.* Retrieved from https://unfccc.int/sites/default/files/resource/901835_France-NC7-2-NC%20-%20FRANCE%20%20-%20EN%20-VF15022018.pdf

UVEK. (2017). *Verkehrsverlagerung.* Retrieved from https://www.uvek.admin.ch/uvek/de/home/verkehr/verkehrsverlagerung.html

VIFG. (n.d.). *Mauteinnahmen und Mautverwendung.* Retrieved from http://www.vifg.de/de/finanzmanagement-bfst-maut/mauteinnahme-und-mautverwendung/

BEACON Bridging European & Local Climate Action

NAVIGANT

adelphi

On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

European
Climate Initiative
EUKI

of the Federal Republic of Germany