Annex 8

to

Denmark's First

Integrated National Energy and Climate Plan

pursuant to Articles 3-11 and ANNEX I of Regulation 2018/1999[Governance]
on the GENERAL FRAMEWORK FOR INTEGRATED
NATIONAL ENERGY AND CLIMATE PLANS

Part 1
General framework
SECTION A: NATIONAL PLAN

3. POLICIES AND MEASURES

3.1. Dimension Decarbonisation

3.1.1. GHG emissions and removals

i. Policies and measures to achieve the target set under Regulation 2018/842[ESR] as referred to in 2.1.1 and policies and measures to comply with Regulation 2018/841[LULUCF], covering all key emitting sectors and sectors for the enhancement of removals, with an outlook to the long-term vision and goal to become a low emission economy and achieving a balance between emissions and removals in accordance with the Paris Agreement.

Content

4 Policies and measures

- including those in accordance with Article 2 of the Kyoto Protocol, and domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures

4.1 CLIMATE POLICY AND THE POLICY-MAKING PROCESS

Since the Brundtland Commission's report, "Our Common Future", from 1987, Denmark's climate policy has developed in collaboration with the different sectors of society, and in line with international climate policy, and results from related scientific research.

Thus, since the end of the 1980s a considerable number of measures to reduce emissions of greenhouse gases have been implemented.

Some of the measures have been implemented with reduction of greenhouse gas emissions as the main objective, others were aimed at achieving environmental improvements for society in general, e.g. by introducing environmental taxes and involving the public in the debate and decisions concerning the environment.

Since 2001, focus has also been on efforts to reduce emissions and meet the near-term international greenhouse gas emission reduction targets – i.e. for 2008-2012 under the first commitment period of the Kyoto Protocol and the EU Burden Sharing, for 2013-2020 under the second commitment period of the Kyoto Protocol and the EU Effort Sharing Decision and for 2021-2030 under the Paris Agreement and the EU burden sharing of the EU National Determined Contribution through the EU Effort Sharing Regulation – with view to meet the long-term target: a climate-neutral society by 2050.

Denmark's international climate targets are described in Box 4.1.

BOX 4.1 INTERNATIONAL CLIMATE TARGETS

Since 1990 Denmark has undertaken or committed itself to several targets with respect to reducing greenhouse gas emissions:

- In accordance with the Climate Convention, to reduce total emissions of greenhouse gases in Denmark, Greenland and the Faroe Islands to the 1990 level by 2000. This target was achieved for total emissions excluding the land-use sector (LULUCF). Due to windfalls total emissions including LULUCF brought the Realm to within 1% of the target.
- As a contribution to stabilisation in the EU, Denmark committed itself to reducing CO_2 emissions in 2000 by 5% compared to the adjusted level for 1990. This target was fulfilled.
- In relation to the Kyoto Protocol, for the period 2008-2012 the EU committed itself to reducing emissions of greenhouse gases on average to 8% below the level in the base year; 1990 for CO_2, methane, and nitrous oxide and either 1990 or 1995 for industrial greenhouse gases. Denmark committed itself to a reduction of 21% as an element of the burden-sharing agreement within the EU. Both Denmark and the EU reached these targets.
- In relation to the period 2013-2020, the EU reached an agreement in December 2008 on a climate and energy package and on a regulation on CO_2 from new vehicles. According to this package the EU is committed to reducing its overall emissions to at least 20% below 1990 levels by 2020. Under the EU burden sharing of the joint EU target for 2020, Denmark is committed to a reduction in non-ETS emissions in the period 2013-2020, rising to 20% by 2020 relative to 2005. The EU is also committed to reducing its ETS emissions to 21% below 2005 levels by 2020. The EU has also set itself the target of increasing the share of renewables in energy use to 20% by 2020. Under burden sharing for this EU target, Denmark is committed to reaching a 30% share of renewables in energy use by 2020.
- In relation to the period 2021-2030, the European Council agreed on the 2030 climate and energy framework in October 2014 and endorsed four important targets of which targets for energy efficiency and renewable energy were revised in 2018: (1) a binding EU target of at least 40% less greenhouse gas emissions by 2030, compared to 1990, (2) a target, binding at EU level, of at least 32% renewable energy consumption in 2030, (3) an indicative target at EU level of at least 32.5% improvement in energy efficiency in 2030 and (4) support the completion of the internal energy market by achieving the existing electricity interconnection target of 10% as a matter of urgency no later than 2020, in particular for the Baltic states and the Iberian Peninsula, and the objective of arriving at a 15% target by 2030. The agreement on the 2030 framework, specifically the EU domestic greenhouse gas reduction target of at least 40%, formed the basis of the EU's contribution to the Paris Agreement. The EU's so-called Intended Nationally Determined Contribution (INDC) was formally approved at an Environment Council meeting in March 2015. In May 2018 the EU member states reached an agreement on the effort sharing for the period 2021-2030, for which the formal implementation is pending. Under the EU burden sharing of the joint EU target for 2030 under the Paris Agreement, Denmark is – in the effort sharing of the joint EU target for non-ETS emissions in 2030 – committed to a reduction in non-ETS emissions in the period 2021-2030 of 39% by 2030 relative to 2005. The EU is also committed to reducing its ETS emissions to achieve the 40% below 1990 levels by 2030 in total greenhouse gas emissions. The EU has also set itself the target of increasing the share of renewables in energy use to 32% by 2030. Denmark will allocate funds that sets a course towards a Renewable Energy share of approximately 55% in energy use by 2030.

The following sections contain more information about Denmark's climate relevant action plans until now and the climate policy framework until 2030 which is the Energy Agreement from June 2018.

This section is followed by sector by sector descriptions of Denmark's climate policies and measures.

4.1.1 National action plans

In 1988 the government issued the Government's Action Plan for Environment and Development. The plan was a follow-up on the Brundtland Report and was based in principle on striving for environmentally sustainable development. One of the main

messages in the plan was the need to integrate environmental considerations into decisions and administration within such sectors as transport, agriculture and energy.

In the years since then, a number of ministries have prepared sector action plans in which the environment is an integral element. The sector action plans deal with the entire development in a sector combined with solutions to environmental problems caused by the sector. The sector plans for energy, transport, forestry, agriculture, the aquatic environment, waste, and development assistance are important examples.

The plans from the 1990s all contained specific environmental objectives and, usually, deadlines for achieving them. In addition, there were a number of concrete initiatives that are intended to lead to achievement of the objectives. Progress has been evaluated regularly to check whether the implementation of the plans resulted in achievement of the objectives. The results of the evaluations have been presented in political reports from the sector ministries or in special follow-up reports.

The evaluations and follow-up have often given rise to the preparation of new action plans, either because additional initiatives have been necessary in order to achieve the objectives or because the development of society or developments within the area in question have made it necessary to change both objectives and initiatives. Major sector plans that have been of importance for the reduction of greenhouse gas emissions are:

- The NPO Action Plan on pollution from livestock manure (1985)
- Action Plan for the Aquatic Environment I (1987)
- Energy 2000 (1990)
- Action plan for sustainable development in the agricultural sector (1991)
- Strategy for sustainable forest management (1994)
- Strategy 2000 - Danish strategy in the development assistance area (1995)
- Energy 21 (1996)
- Action plan for reduction of the transport sector's CO_2 emissions (1996)
- National sub-strategy for Danish environmental and energy research (1996)
- Action Plan for the Aquatic Environment II (1998)
- Action Plan II - Ecology in Development (1999)
- Waste 21 (1999)
- Action plan for reduction of industrial greenhouse gas emissions (2000)
- Reduction of the transport sector's CO_2 emissions - possibilities, policies and measures (2000)
- Reduction of the transport sector's CO_2 emissions - the government's action plan (2001)
- Denmark's national forest programme (2002)
- Denmark's National Strategy for Sustainable Development (2002)
- National Climate Strategy for Denmark (2003)
- Waste Strategy 2005-2008 (2003)
- Action Plan for the Aquatic Environment III (2004)
- 1st National Allocation Plan 2005-2007 under the EU-ETS (2004)
- Energy Strategy 2025 (2005)
- Action Plan for Strengthened Energy-saving Efforts (2005)
- 2nd National Allocation Plan 2008-2012 under the EU-ETS (2007)
- Political agreement on Energy (2008)
- Political agreement on a Green Transport Vision for Denmark (2009)
- Political agreement on a Tax Reform (2009)

- Growth with Consideration – the government's strategy for sustainable development (2009)
- Strategy for reducing energy consumption in buildings (2009)
- Political agreement on a Green Growth Plan (2009)
- Waste Strategy 2009-2012 – Part I (2009)
- Waste Strategy 2009-2012 – Part II (2010)
- Energy Strategy 2050 (2011)
- Our Future Energy (2011)
- Political Agreement on Energy (2012)
- The Danish Climate Policy Plan – Towards a low carbon society (2013)
- The Agricultural Package (2016)
- The Energy Agreement (2018)
- The Climate and Air proposal "Together for a greener future" (2018)

The sector plans deal with different aspects of the climate problem. In the energy and transport sectors, the main environmental concern has been the emissions of the greenhouse gas CO_2. The plans in these sectors were therefore to a great extent concerned with reducing CO_2.

The frameworks for the Danish energy sector, however, have changed quite significantly over a short period of time. The goal of Danish energy policy today is to create well-functioning energy markets within frameworks that secure cost-effectiveness, security of supply, environmental concerns and efficient use of energy under conditions of a fully liberalised energy sector. Electricity production from Danish power plants is controlled by market forces and traded freely across national borders.

The introduction of CO_2 quota regulation as a common EU instrument has therefore been of absolute importance to Denmark meeting its climate commitments. From 2005, quota regulation through the EU emissions trading scheme (EU ETS) has been the key instrument to ensuring that the Danish energy sector can contribute to the reductions requisite to fulfilling Denmark's climate commitments.

The other sector plans are not primarily focused on reducing greenhouse gas emissions, in part because the sectors are battling with other major environmental problems. The main concern in the agricultural sector has been pollution of the aquatic environment. In the waste sector it has been reduction of the volume of waste, and in the industrial sector, reduction of emissions/discharges of harmful substances to the atmosphere/aquatic environment, the use of toxic substances, etc.

However, the implementation of the sector plans has to a great extent also resulted in reduction of greenhouse gas emissions. For example, the reduction in nitrogen emissions from the agricultural sector, which is the result of the aquatic environment plans, is at the same time reducing emissions of the greenhouse gas nitrous oxide. The initiatives to reduce waste quantities mean fewer landfill sites and thus less formation and emissions of methane, and the on-going increase in forested area will mean increased removals of CO_2.

In addition, the energy and transport plans meant that changes were made in the energy and transport sectors. The initiatives in the energy sector have resulted in

reduced energy consumption despite significant economic growth and, with that, reduced CO_2 emissions.

On the environment policy front, Denmark has participated actively in improving environmental protection in Europe through the EU cooperation and through bilateral environmental assistance to Central and Eastern European countries. On a number of points, the EU's environmental regulation has put Europe ahead of the rest of world environmentally. There are also many examples of EU rules having helped to strengthen environmental protection in Denmark. With the adoption of the Amsterdam Treaty, sustainable development became a main objective for the EU, and integrating environmental considerations in the EU's sector policies became an obligation.

4.1.2 Denmark's Climate Policy

4.1.2.1 ***The 2018 Energy Agreement***

On 29 June 2018 an Energy Agreement on future Danish energy policy until 2024 - and for some elements until 2030 - was reached with all Parties in the parliament[1].

The 2018 Energy Agreement is an agreement on allocating funding that sets a course towards a share of renewable energy of approximately 55% by 2030. The agreement will also give Denmark a share of renewable energy in electricity above 100% of consumption, while ensuring that at least 90% of district heating consumption is based on energy sources other than coal, oil or gas by 2030.

The parties to the agreement have also agreed that Denmark will work towards net zero emissions, in accordance with the Paris Agreement, and advocate for the adoption of a target of net zero emissions in the EU and Denmark by 2050 at the latest.

The agreement includes the following initiatives:

E1) World class offshore wind

E2) Renewable energy on market conditions

E3) Reduction of taxes on electricity and restructuring of surplus heat utilisation

E4) Targeted energy savings (E4a) and Support schemes to promote replacement of oil-fired boilers in favour of individual heat pumps (E4b)

E5) Modernisation of the heating sector and mitigating the impacts of eliminating the “base subsidy”

E6) Strengthened energy and climate research

E7) Denmark leading the way in exports of green energy solutions

E8) A smart and flexible energy system

E9) Funding for green transport

E10) Reserve for additional investments in RE from 2025 onwards

The elements in the 2018 Energy Agreement are described in greater detail in the sector chapters below.

[1] https://en.efkm.dk/energy-and-raw-materials/energy-proposal/

4.1.2.2 Additional measures in 2019

In October 2018, the former government published its Climate and Air proposal "Together for a greener future".

The climate and air proposal included additional initiatives of which the following have been adopted, implemented or are under implementation as of 1 November 2019:

- A commission for the transition to green cars must show the way (Commission established in February 2019) [C2 in draft NECP].
- No registration tax in 2019 and 2020 on green cars priced below 400,000 DKK (implemented) [C3 in draft NECP].
- Greater powers for municipalities to grant parking discounts for low-emission cars (Statutory order issued in February 2019) [C6 in draft NECP].
- Ensuring parking spaces with charging stations for low-emission cars (under implementation, meetings with stakeholders have been held) [C7 in draft NECP].
- Denmark's municipalities can grant low-emission cars permission to drive in bus lanes (Statutory order issued in March 2019) [C8 in draft NECP].
- An end to carbon emissions and air pollution from busses in Denmark's cities by 2030 – starting with the first step in 2020, where new buses must be CO_2-neutral (an introductory meeting with stakeholders has been held) [C10 in draft NECP].
- Clean air in Denmark's big cities – bringing environmental zones up to date (Act adopted in May 2019) [C11 in draft NECP].
- Petrol and diesel out of taxi operations by 2030 (12a on increased energy efficiency demands for new taxis: Statutory order issued in August 2019 / 12b on guaranteed licence for zero emission taxis (300 out of 750 until 1 January 2021): Act adopted in May 2019 with entering into force as of 1 July 2019) [C12 in draft NECP].
- Benefits for green taxis (13a on change to the relevant statutory order: adopted in March 2019 / 13b on green taxi priorities at Copenhagen Airport: Working group with airport authorities established) [C13 in draft NECP].
- Higher scrapping premium for old diesel cars (implemented 1 February – 1 July 2019)[2] [C14 in draft NECP].
- All new asphalt on national roads must be climate-friendly, if an ongoing pilot project can confirm the expected effects and durability of the asphalt (the results of an analysis are expected in 2019) [C16 in draft NECP].
- More environmentally-friendly cruise tourism in the Baltic Sea (funds have been allocated for four years: in total DKK 10 Million and one conference has been held) [C18 in draft NECP].
- Improvement of biogas plants (efforts initiated in 2019) [C21 in draft NECP].
- Stronger research efforts in agriculture. A DKK 90 million) [C23 in draft NECP] research programme has been established in 2019 for the period 2019-21. Extra DKK 30 million has been allocated to this initiative in 2022. Furthermore, DKK 40 mio. has been allocated to climate research in agriculture in 2020 as part of the Danish Green Development and Demonstration Programme (GUDP)).
- Promotion of precision agriculture (preparation of a pilot project in 2019) [C24 in draft NECP]. In the ongoing pilot projects on precision farming and fertilizer, efforts will also be made to calculate the possible side effects in relation to reducing greenhouse gases. The relevant outcome will be integrated in future work on climate.]

[2] https://mst.dk/service/nyheder/nyhedsarkiv/2019/jan/nu-fordobles-skrotpraemien-for-gamle-dieselbiler/ and https://mst.dk/service/nyheder/nyhedsarkiv/2019/jun/stop-for-ansoegninger-til-forhoejet-skrotpraemie-for-gamle-dieselbiler-pr-1-juli/

- Strategy for development of the natural gas system (under elaboration) [C30 in draft NECP].
- Analysis to improve the monitoring and accounting of carbon dioxide storage in soils and forests (work on such an analysis started in May 2019) [C35 in draft NECP].

The elements implemented or under implementation are described in greater detail in the sector chapters below.

4.1.2.3 Denmark's climate policy and the EU climate policy

Danish climate policy is based on two pillars – the European and the national.

The EU is a player in international climate negotiations. In 2008, the EU Climate and Energy Package established EU targets for 2020 of a 20% reduction in greenhouse gases compared with 1990, 20% renewable energy and 20% energy-efficiency improvements cf. Box 4.1.The implementation of the Paris Agreement requires an ambitious common EU approach for the period after 2020. The need for a common EU approach was highlighted by the European Council in May 2013. After more than two years of negotiations the final elements of the "Clean Energy for all Europeans" package was adopted in 2018. The package is set to deliver on the EU targets for 2030 of a 40% reduction in greenhouse gases compared to 1990 levels, at least a 32% share of renewable energy consumption and an indicative target for an improvement in energy efficiency at EU level of at least 32.5% (compared to projections) cf. Box 4.1.

4.2 LEGISLATIVE ARRANGEMENTS AND ENFORCEMENT AND ADMINISTRATIVE PROCEDURES

The legal basis for the division of powers into the legislative, executive, and judicial power is the Danish Constitution, *Danmarks Riges Grundlov*[3].

The Constitution includes the legal basis for how the Regent acts on behalf of the Realm in international affairs, and the Regent cannot act without the consent of the Folketing in any way that increases or restricts the area of the Realm, or enter into obligations requiring cooperation of the Folketing or which in some other way are of great significance to the Realm. Neither can the Regent, without the consent of the Folketing, cancel an international agreement entered into with the consent of the Folketing.

After a motion from the government, the Folketing thus gave its consent in 2002, allowing Her Majesty Queen Margrethe the Second, on behalf of the Realm and with territorial reservations for the Faroe Islands, to ratify the Kyoto Protocol. This was on 31 May 2002.

Denmark's implementation of the Kyoto Protocol in the first commitment period 2008-2012 has been effectuated by following up on the national Climate Strategy, sector-policy strategies with climate considerations, and concrete initiatives contributing to limiting or reducing greenhouse gas emissions, and implementation

[3] The Danish Constitution (Danmarks Riges Grundlov) (http://www.retsinfo.dk/_GETDOCI_/ACCN/A19530016930-REGL /: http://www.folketinget.dk/pdf/constitution.pdf)

of the other parts of the Kyoto Protocol. The legislation necessary to do this has been adopted in pursuance of the Constitution regulations concerning legislative powers.

Pursuant to the Constitution, the Regent is the ultimate authority, cf. paragraphs 12-14:

"12. Subject to the limitations laid down in this Constitutional Act, the King shall have supreme authority in all the affairs of the Realm, and shall exercise such supreme authority through the Ministers.

13. The King shall not be answerable for his actions; his person shall be sacrosanct. The Ministers shall be responsible for the conduct of government; their responsibility shall be defined by statute.

14. The King shall appoint and dismiss the Prime Minister and the other Ministers. He shall decide upon the number of Ministers and upon the distribution of the duties of government among them. The signature of the King to resolutions relating to legislation and government shall make such resolutions valid, provided that the signature of the King is accompanied by the signature or signatures of one or more Ministers. A Minister who has signed a resolution shall be responsible for the resolution."

With this background, the Regent delegates responsibility for various functions to government ministers through Royal resolutions. This makes the various ministers for different areas responsible for, e.g. making proposals for new/amended legislation made necessary by the Kyoto Protocol, enforcement of legislation and initiation of necessary administrative procedures.

The total set of regulations (in Danish) can be accessed via Retsinformation[4] (online legal information system). Legislation concerning measures of importance to Denmark's commitments under the Kyoto Protocol will be enforced pursuant to the current legal basis, including pursuant to any penalty clause. Enforcement could also involve the judicial power.

As regards the institutional arrangements for the implementation the Kyoto Protocol concerning activities in connection with participation in the mechanisms under Articles 6, 12, and 17 of the Kyoto Protocol, these tasks have been delegated to the Danish Energy Agency (DEA) under the Ministry of Energy, Utilities and Climate. The DEA is also responsible for legislation and administration of the EU emission trading scheme. The supplementary regulations regarding the approval and use of JI/CDM credits and the Registry are now regulated in Statutory Order No. 118 dated 28 February 2008 with later amendments (https://www.retsinformation.dk/Forms/R0710.aspx?id=144489).

Among the national legislative arrangements and administrative procedures that seek to ensure that the implementation of activities under Article 3, paragraph 3, and the elected activities under Article 3, paragraph 4, also contribute to the conservation of biodiversity and sustainable use of natural resources is The Forest Act (Consolidating Act No. 315 of 28 March 2019), and the implementation thereof by the Danish Environmental Protection Agency under the Ministry of Environment and Food.

[4] http://www.retsinfo.dk/

Preservation of areas designated as forest reserve land and protection of natural habitats and habitats for species are among the foremost objectives of the Forest Act.

Furthermore, activities under Article 3, paragraph 3, and the elected activities under Article 3, paragraph 4 have to be implemented in accordance with Natura 2000, which are the Special Areas of Conservation (SAC) designated according to the European Union's Habitats Directive and the Special Protection Areas (SPA) designated according to the European Union's Birds Directive. The Danish Ramsar Sites are included in the Special Protection Areas.

The Ministry of Environment and Food of Denmark, has the overall responsibility for the implementation of the Habitats Directive and the Birds Directive. The implementation includes the designation of 262 Special Area of Conservation, 113 Special Protection Areas and 28 Ramsar Sites. The rules for administration of the Danish Natura 2000 are laid down in Executive Order No. 1595 of 6 December 2018 on the Designation and Administration of Internationally Protected Sites and the Protection of Certain Species. Similar rules are integrated in other ministries legislation e.g. fisheries and constructions in marine areas.

4.3 POLICIES AND MEASURES AND THEIR EFFECTS

In this section, the individual measures relevant to Denmark's climate policy are described. An overview of Denmark's portfolio of climate relevant policies and measures is contained in Chapter 3 of the NECP (Table 8 with existing policies and measures).

Sections 4.3.1-4.3.4 includes descriptions of the cross-sectoral policies and measures, allowance regulation, the Kyoto Protocol mechanisms, taxes and duties and the national green climate fund. Sections 4.3.5-4.3.9 contains descriptions of policies and measures in the following IPCC source/sink and sector categories: Energy (including Transport), Industrial Processes and Product Use, Agriculture, LULUCF (Land-use, Land-use change and Forestry) and Waste.

Table 4.1 shows how the allocation to be used in connection with the annual emission inventories (the CRF/IPCC format) is aggregated into the sectors included in this Chapter on policies and measures.

TABLE 4.1 AGGREGATION OF SOURCE, SINK AND SECTOR CATEGORIES IN THE CRF/IPCC FORMAT INTO THE SECTORS INCLUDED IN THIS CHAPTER

Sectors in this chapter and Chapter 5		Sources/Sectors in the CRF/IPCC format	
Energy - with subsections on:		1.	Fuel combustion activities (1A) and Fugitive emissions from fuels (1B)
	Business	1A2+ 1A4a+ 1A4c.	Manufacturing Industries and Construction Commercial/Institutional Agriculture, Forestry and Fisheries
	Households	1A4b	Residential
	Transport	1A3.	Transport (national)
Industrial Processes and Product Use		2.	Industrial processes and Product Use
Agriculture		3.	Agriculture
LULUCF		4.	Land-use, Land-use Changes and Forestry (LULUCF).
Waste		5.	Waste

Table 4.2 and Figure 4.8 show the main result of this aggregation, including indirect CO_2 emissions, for the historic greenhouse gas inventories in 1990, KP2 base year estimate for 1990/95[5] and 2017 as well as the August 2019 projections of annual emissions in 2020, 2025, 2030, 2035 and 2040 in the "with existing measures" (WEM) scenario[6] – with and without emissions and removals in connection with land use, land-use change and forestry (LULUCF)[7].

In accordance with the reporting guidelines, the following sector sections in this chapter are subdivided by gas.

The effects of existing policies and measures

Regarding the greenhouse-gas-reducing effects of existing measures, a major ex-post analysis of Denmark's efforts in 1990-2001 to reduce emissions of CO_2 and other greenhouse gases, and associated costs was finalised and published in March 2005 in the report, "Denmark's CO_2 emissions - the effort in the period 1990-2001 and the associated costs"[8], hereafter *the Effort Analysis*. The results of the *Effort Analysis* are described in Denmark's 7th National Communication under the UNFCCC[9] (Annex B2).

Prior to this analysis, quantitative estimates of the effect of separate measures on greenhouse gas emissions were often limited to ex-ante estimates before the measure in question was adopted. In a few cases, the implementation of a measure was followed by an ex-post evaluation. A major reason that only a few ex-post evaluations of individual measures have been carried out is that it is often difficult to clearly attribute an observed greenhouse gas reduction to a particular measure, since many areas (sectors/sources) are affected by several measures at the same time.

In the analysis of the importance of selected, implemented measures for greenhouse gas emissions as a result of efforts in 1990-2001, the effect and cost of a number of measures were estimated - both for the year 2001 and for the period 2008-2012. Thus, the latter case is a so-called without measures projection i.e. without the effects of measures implemented since 1990, which gives estimates of the size of mean annual greenhouse gas emissions in 2008-2012, if the measures until 2001 had not been implemented.

Please note that the statistical base for *the Effort Analysis* has included the emissions inventory submitted to the EU and the UN in 2003 (covering 1990-2001) and the "with measures" baseline projection (2008-2012), i.e. without additional measures, published in February 2003 together with the Climate Strategy of the government in 2003.

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[5] Under the second commitment period of the Kyoto Protocol, Denmark's base year is 1990 for CO_2, methane and nitrous oxide, and 1995 for the industrial gases (HFCs, PFCs, SF_6 and NF_3 – however with no emissions of the latter) cf. Article 3.8 of the Protocol from the inventory reported, reviewed and resubmitted in 2016-2017 (https://unfccc.int/sites/default/files/resource/docs/2017/irr/dnk.pdf).

[6] https://presse.ens.dk/news/basisfremskrivning-2018-nu-paa-engelsk-316511

[7] Under the Kyoto Protocol, the LULUCF category is dealt with separately under Articles 3.3 and 3.4.

[8] Denmark's CO_2 emissions - the effort in the period 1990-2001 and the associated costs, Report from the Danish EPA, No. 2, April 2005 (Main report http://www.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and Annex report: http://www.mst.dk/udgiv/publikationer/2005/87-7614-589-1/html).

[9] https://unfccc.int/sites/default/files/resource/8057126_Denmark-NC7-BR3-2-NC7-DNK-Denmarks-NC7-and-BR3_1January2018-12MB.pdf

In December 2013 the Ministry of Climate, Energy and Building published a paper with another ex-post analysis in response to recommendations in a report published by the National Audit Office in October 2012. This paper contains an evaluation of the effects of certain climate change mitigation measures selected by the National Audit Office. A translation of this paper is contained in Denmark's 7th National Communication under the UNFCCC[10] (Annex B3).

In December 2015 estimates of the total effect of the group of policies and measures that promote the use of renewable energy (RE-PAMs) and of the total effect of the group of policies and measures that promote energy efficiency (EE-PAMs) were elaborated. In September 2019 these estimates were updated on the basis of the most recent energy statistics covering the period 1990-2017 and the August 2019 "with measures" projection covering the period until 2040. The methodologies are further described in Denmark's 7th National Communication under the UNFCCC[11] (Annex B4).

Separate estimate of the effect of the 2018 Energy Agreement

In this report the effects of most of the additional policies and measures *adopted* with the 2018 Energy Agreement is included in the "With Existing Measures" (WEM) greenhouse gas projection scenario.

In 2018, it was estimated that the *2018 Energy Agreement* alone will provide a 10-11 million tonnes reduction in Denmark's total greenhouse gas emissions by 2030. The majority of these reductions will be within sectors covered by the EU's Emissions Trading System (EU ETS) as approximately 0.15-0.25 million tonnes CO_2 is estimated to be the reduction in 2030 outside of the EU ETS (non-ETS). Accumulated over the non-ETS reduction commitment period 2021-2030 the energy agreement's initiatives are expected to reduce carbon emissions from the non-ETS sectors by approximately 1.1 to 1.5 million tonnes CO_2 in the period 2021-2030. The largest contributions come from new energy saving subsidies and the reduced electricity heating tax which makes it more attractive to switch to heat pumps. With these and other initiatives, the agreement will help Denmark reach its 39% greenhouse gas emissions reduction target by 2030 in the non-ETS sectors.

[10] https://unfccc.int/sites/default/files/resource/8057126_Denmark-NC7-BR3-2-NC7-DNK-Denmarks-NC7-and-BR3_1January2018-12MB.pdf

[11] https://unfccc.int/sites/default/files/resource/8057126_Denmark-NC7-BR3-2-NC7-DNK-Denmarks-NC7-and-BR3_1January2018-12MB.pdf

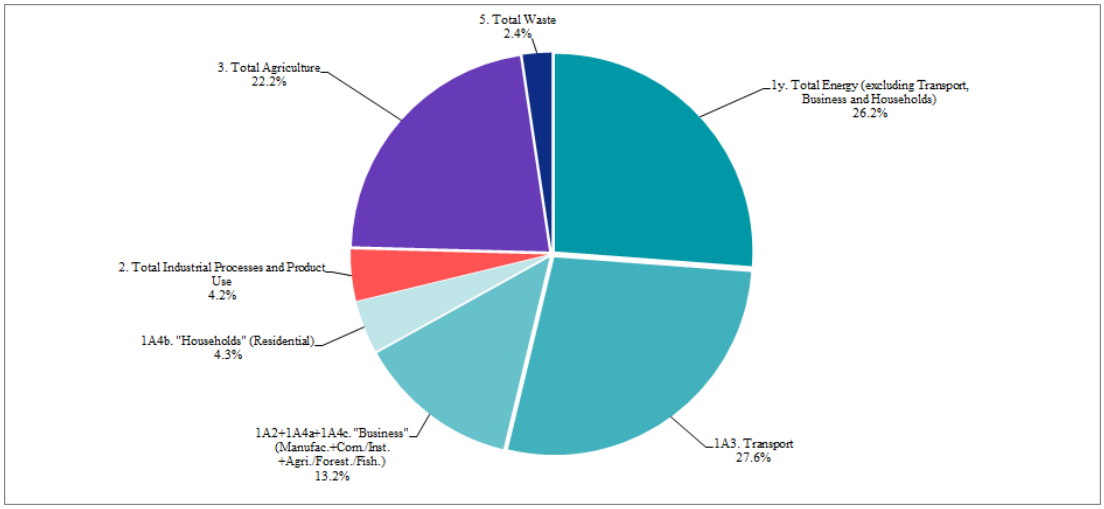
TABLE 4.2 DENMARK'S GREENHOUSE GAS EMISSIONS 1990-2017, THE BASE YEAR UNDER THE SECOND COMMITMENT PERIOD OF THE KYOTO PROTOCOL AND THE MAIN RESULTS OF THE AUGUST 2019 "WITH (EXISTING) MEASURES" (WEM) PROJECTION FOR 2020, 2025, 2030, 2035 AND 2040 BY SECTOR AND BY GAS (INCLUDING INDIRECT CO2), WITH AND WITHOUT LULUCF AS REPORTED UNDER THE UNFCCC

Source: Nielsen et al. (2019a), Nielsen et al. (2019b – to be published), Danish Energy Agency (2019) and Ministry of Climate, Energy and Utilities

GHG emissions (1990-2017) and projections (2018-2040)	1990 MtCO2e	*1990 % share for/in sector*	KP2 BY MtCO2e	*KP2 BY % share for/in sector*	2017 MtCO2e	*2017 % share for/in sector*	Change from 1990 (%)	Change from KP2 BY	2020 MtCO2e	*2020 % share for/in sector*	Change from 1990 (%)	Change from KP2 BY	2025 MtCO2e	*2025 % share for/in sector*	Change from 1990 (%)	2030 MtCO2e	*2030 % share for/in sector*	Change from 1990 (%)	2035 MtCO2e	*2035 % share for/in sector*	Change from 1990 (%)	2040 MtCO2e	*2040 % share for/in sector*	Change from 1990 (%)
Total (including LULUCF, with indirect CO_2)	**75.2**	***107.0***	**70.8**	***100.0***	**50.9**	***106.2***	**-32.4**	**-28.2**	**46.9**	***105.7***	**-37.7**	**-33.8**	**43.7**	***105.8***	**-41.9**	**41.7**	***108.9***	**-44.6**	**40.0**	***108.3***	**-46.8**	**39.7**	***110.2***	**-47.2**
CO_2 (with indirect CO_2)	59.4	*84.5*	54.8	*77.4*	37.8	*79.0*	-36.3	-31.0	34.5	*77.7*	-42.0	-37.1	31.5	*76.1*	-47.0	29.6	*77.2*	-50.2	28.0	*75.7*	-52.9	27.5	*76.4*	-53.6
Methane	7.8	*11.1*	7.9	*11.1*	7.1	*14.8*	-9.2	-10.0	6.7	*15.2*	-13.4	-14.3	6.8	*16.4*	-12.9	6.8	*17.8*	-12.4	6.8	*18.3*	-13.2	6.8	*18.8*	-13.3
Nitrous oxide	8.0	*11.4*	7.8	*11.0*	5.5	*11.4*	-31.5	-29.8	5.3	*12.0*	-33.6	-32.0	5.2	*12.6*	-35.0	5.1	*13.3*	-36.3	5.1	*13.7*	-36.4	5.2	*14.4*	-34.9
Industrial gases	0.0	*0.1*	0.3	*0.5*	0.5	*1.0*	1036.5	39.9	0.4	*0.8*	734.6	2.7	0.3	*0.7*	614.6	0.2	*0.6*	398.4	0.2	*0.6*	398.4	0.2	*0.6*	398.4
Total (without LULUCF, with indirect CO_2)	**70.3**	***100.0***	**70.8**	***100.0***	**47.9**	***100.0***	**-31.9**	**-32.3**	**44.3**	***100.0***	**-36.9**	**-37.4**	**41.3**	***100.0***	**-41.2**	**38.3**	***100.0***	**-45.5**	**37.0**	***100.0***	**-47.4**	**36.0**	***100.0***	**-48.7**
CO_2 (with indirect CO_2)	54.7	*77.8*	54.8	*77.4*	35.1	*73.2*	-35.9	-36.0	32.1	*72.4*	-41.3	-41.4	29.2	*70.7*	-46.5	26.4	*68.8*	-51.8	25.1	*67.9*	-54.1	24.1	*66.8*	-56.0
Methane	7.6	*10.8*	7.9	*11.1*	6.9	*14.4*	-9.4	-12.5	6.6	*14.8*	-13.4	-16.4	6.6	*16.0*	-13.0	6.6	*17.3*	-12.6	6.6	*17.8*	-13.5	6.6	*18.2*	-13.7
Nitrous oxide	8.0	*11.3*	7.8	*11.0*	5.5	*11.4*	-31.6	-30.1	5.3	*12.0*	-33.5	-32.0	5.2	*12.6*	-34.8	5.1	*13.3*	-36.2	5.1	*13.7*	-36.3	5.2	*14.4*	-34.8
Industrial gases	0.0	*0.1*	0.3	*0.5*	0.5	*1.0*	1036.5	39.9	0.4	*0.8*	734.6	2.7	0.3	*0.7*	614.6	0.2	*0.6*	398.4	0.2	*0.6*	398.4	0.2	*0.6*	398.4
1. Total Energy (with indirect CO_2)	**53.5**	***76.1***	**53.6**	***75.7***	**34.1**	***71.2***	**-36.3**	**-36.4**	**30.9**	***69.8***	**-42.2**	**-42.3**	**28.0**	***67.6***	**-47.8**	**24.9**	***65.0***	**-53.5**	**23.6**	***63.9***	**-55.9**	**22.5**	***62.3***	**-58.0**
CO_2 (with all indirect CO_2 here and no electricity trade after 2016)	52.8	*98.6*	52.9	*98.6*	33.3	*97.7*	-36.8	-37.0	30.2	*97.8*	-42.7	-42.8	27.3	*97.6*	-48.3	24.3	*97.6*	-54.0	23.0	*97.6*	-56.3	21.9	*97.6*	-58.4
Methane	0.4	*0.7*	0.4	*0.7*	0.4	*1.1*	-3.8	2.4	0.3	*1.0*	-21.9	-16.8	0.3	*1.1*	-23.0	0.3	*1.0*	-34.2	0.2	*1.0*	-41.6	0.2	*0.9*	-47.6
Nitrous oxide	0.4	*0.7*	0.4	*0.7*	0.4	*1.2*	11.9	11.0	0.4	*1.3*	7.9	7.0	0.4	*1.4*	6.2	0.3	*1.4*	-3.9	0.3	*1.4*	-6.9	0.3	*1.4*	-9.5
2. Total Industrial Processes and Product Use	**2.3**	***3.3***	**2.6**	***3.7***	**2.0**	***4.2***	**-14.3**	**-24.0**	**2.0**	***4.5***	**-14.6**	**-24.3**	**2.1**	***5.0***	**-12.0**	**2.1**	***5.4***	**-11.6**	**2.1**	***5.6***	**-11.6**	**2.1**	***5.9***	**-8.7**
CO_2	1.3	*54.5*	1.3	*48.3*	1.5	*74.9*	17.8	18.0	1.6	*81.2*	27.3	27.5	1.7	*84.3*	35.9	1.8	*88.8*	43.9	1.8	*88.8*	43.9	1.9	*89.1*	49.1
Methane	0.0	*0.1*	0.0	*0.1*	0.0	*0.1*	-6.0	-6.6	0.0	*0.1*	11.9	11.2	0.0	*0.1*	8.8	0.0	*0.1*	5.7	0.0	*0.1*	2.6	0.0	*0.1*	-0.5
Nitrous oxide	1.0	*43.5*	1.0	*38.6*	0.0	*1.0*	-98.1	-98.1	0.0	*1.0*	-98.1	-98.1	0.0	*0.9*	-98.1	0.0	*0.9*	-98.1	0.0	*0.9*	-98.1	0.0	*0.9*	-98.1
Industrial gases	0.0	*1.8*	0.3	*13.0*	0.5	*24.0*	1036.5	39.9	0.4	*17.7*	734.6	2.7	0.3	*14.7*	614.6	0.2	*10.2*	398.4	0.2	*10.2*	398.4	0.2	*9.9*	398.4
3. Total Agriculture	**12.7**	***18.0***	**12.8**	***18.1***	**10.6**	***22.2***	**-16.0**	**-16.8**	**10.4**	***23.5***	**-17.7**	**-18.4**	**10.4**	***25.2***	**-17.8**	**10.5**	***27.4***	**-17.3**	**10.5**	***28.4***	**-17.1**	**10.8**	***29.9***	**-15.0**
CO_2	0.6	*4.9*	0.6	*4.8*	0.2	*2.1*	-64.6	-64.6	0.2	*2.1*	-65.0	-65.0	0.2	*2.0*	-65.8	0.2	*2.0*	-66.6	0.2	*2.0*	-66.6	0.2	*1.9*	-66.6
Methane	5.6	*44.1*	5.8	*45.6*	5.5	*52.1*	-0.7	-4.8	5.5	*52.4*	-2.1	-6.1	5.6	*53.4*	-0.5	5.7	*54.4*	2.1	5.7	*54.6*	2.6	5.9	*54.4*	5.0
Nitrous oxide	6.5	*51.0*	6.3	*49.6*	4.9	*45.8*	-24.6	-23.1	4.7	*45.5*	-26.6	-25.2	4.6	*44.6*	-28.2	4.6	*43.6*	-29.4	4.6	*43.5*	-29.4	4.7	*43.6*	-27.3
4. Total Land-Use Categories (LULUCF)	**4.9**	***7.0***	**0.0**	***0.0***	**3.0**	***6.2***	**-39.8**	-	**2.5**	***5.7***	**-48.6**	-	**2.4**	***5.8***	**-51.5**	**3.4**	***8.9***	**-31.2**	**3.1**	***8.3***	**-37.7**	**3.7**	***10.2***	**-25.5**
CO2 (for KP2 BY only GHG emissions from deforestation)	4.7	*95.5*	0.0	*100.0*	2.8	*92.6*	-41.7	-	2.4	*93.3*	-49.8	-	2.2	*92.5*	-53.0	3.2	*94.4*	-32.0	2.9	*93.6*	-39.0	3.5	*94.4*	-26.4
Methane	0.2	*3.9*	0.0	*0.0*	0.2	*6.5*	-0.8	-	0.2	*6.5*	-14.4	-	0.2	*7.3*	-9.8	0.2	*5.4*	-5.7	0.2	*6.2*	-1.6	0.2	*5.4*	2.5
Nitrous oxide	0.0	*0.6*	0.0	*0.0*	0.0	*1.0*	3.7	-	0.0	*0.2*	-81.4	-	0.0	*0.2*	-78.7	0.0	*0.2*	-76.0	0.0	*0.2*	-73.3	0.0	*0.2*	-70.5
5. Total Waste	**1.8**	***2.5***	**1.8**	***2.5***	**1.1**	***2.4***	**-35.8**	**-35.9**	**1.0**	***2.2***	**-44.8**	**-44.9**	**0.9**	***2.2***	**-48.0**	**0.9**	***2.2***	**-51.7**	**0.8**	***2.1***	**-55.6**	**0.7**	***1.8***	**-62.7**
CO_2	0.0	*1.2*	0.0	*1.0*	0.0	*1.4*	-22.7	-10.5	0.0	*1.8*	-12.6	1.3	0.0	*1.9*	-12.6	0.0	*2.1*	-12.6	0.0	*2.3*	-12.6	0.0	*2.7*	-12.6
Methane (here including the estimated effects of biocovers)	1.6	*92.0*	1.7	*94.8*	1.0	*85.1*	-40.6	-42.5	1.0	*104.5*	-37.3	-39.3	0.8	*83.2*	-52.9	0.7	*79.8*	-58.0	0.6	*78.0*	-62.3	0.5	*74.4*	-69.9
Nitrous oxide	0.1	*6.9*	0.1	*4.2*	0.2	*13.5*	25.4	106.1	0.2	*15.6*	24.6	104.9	0.2	*16.7*	25.7	0.2	*18.1*	26.6	0.2	*19.8*	27.4	0.2	*22.9*	23.8
1x. Total Energy (excluding Transport)	**42.8**	***60.8***	**42.9**	***60.6***	**20.9**	***43.6***	**-51.1**	**-51.2**	**17.6**	***39.6***	**-58.9**	**-59.0**	**14.6**	***35.4***	**-65.8**	**12.1**	***31.7***	**-71.6**	**11.6**	***31.4***	**-72.8**	**11.2**	***31.1***	**-73.8**
CO_2 (with all indirect CO_2 here and no electricity trade after 2016)	42.2	*98.7*	42.3	*98.7*	20.3	*97.0*	-51.9	-52.1	17.0	*96.9*	-59.7	-59.8	14.1	*96.4*	-66.6	11.7	*96.4*	-72.3	11.2	*96.6*	-73.4	10.8	*96.7*	-74.4
Methane	0.3	*0.7*	0.3	*0.7*	0.4	*1.7*	17.4	17.8	0.3	*1.7*	-4.8	-4.5	0.3	*2.0*	-6.2	0.2	*2.0*	-20.3	0.2	*1.9*	-29.7	0.2	*1.7*	-37.1
Nitrous oxide	0.3	*0.6*	0.3	*0.6*	0.3	*1.3*	0.9	0.2	0.2	*1.4*	-5.9	-6.6	0.2	*1.6*	-10.4	0.2	*1.6*	-25.3	0.2	*1.6*	-29.3	0.2	*1.6*	-31.7
1A3 Transport	**10.8**	***15.3***	**10.7**	***15.2***	**13.2**	***27.6***	**22.9**	**23.1**	**13.4**	***30.2***	**24.3**	**24.5**	**13.3**	***32.3***	**24.0**	**12.8**	***33.3***	**18.6**	**12.0**	***32.4***	**11.5**	**11.3**	***31.3***	**4.8**
CO_2	10.6	*98.3*	10.6	*98.5*	13.1	*98.9*	23.5	23.5	13.2	*98.9*	25.0	25.0	13.2	*98.8*	24.6	12.6	*98.7*	19.1	11.8	*98.7*	11.9	11.1	*98.6*	5.1
Methane	0.1	*0.7*	0.1	*0.5*	0.0	*0.1*	-86.3	-80.9	0.0	*0.1*	-88.2	-83.6	0.0	*0.1*	-88.8	0.0	*0.1*	-88.2	0.0	*0.1*	-88.1	0.0	*0.1*	-88.5
Nitrous oxide	0.1	*0.9*	0.1	*0.9*	0.1	*1.1*	40.6	39.3	0.1	*1.1*	43.9	42.6	0.1	*1.1*	49.8	0.2	*1.2*	52.0	0.2	*1.3*	51.8	0.1	*1.3*	48.6
1y. Total Energy (excluding Transport, Business and Households)	**28.1**	***39.9***	**28.2**	***39.8***	**12.5**	***26.2***	**-55.3**	**-55.5**	**9.9**	***22.2***	**-64.9**	**-65.0**	**7.5**	***18.1***	**-73.4**	**5.4**	***14.1***	**-80.8**	**5.3**	***14.3***	**-81.2**	**4.9**	***13.7***	**-82.5**
CO_2 (with all indirect CO_2 here and no electricity trade after 2016)	27.8	*99.0*	27.9	*99.0*	12.2	*97.3*	-56.1	-56.2	9.6	*97.2*	-65.5	-65.6	7.2	*96.2*	-74.1	5.2	*95.8*	-81.4	5.1	*95.9*	-81.7	4.7	*95.9*	-83.0
Methane	0.1	*0.5*	0.1	*0.5*	0.2	*1.6*	43.2	43.2	0.2	*1.6*	9.8	9.8	0.2	*2.2*	18.0	0.1	*2.6*	-0.3	0.1	*2.4*	-8.0	0.1	*2.4*	-14.9
Nitrous oxide	0.1	*0.5*	0.1	*0.5*	0.1	*1.1*	-5.3	-5.0	0.1	*1.3*	-10.9	-10.7	0.1	*1.6*	-15.3	0.1	*1.6*	-36.6	0.1	*1.6*	-37.9	0.1	*1.7*	-40.8
1A2+1A4a+1A4c: "Business" (Manufac.+Com./Inst.+Agri./Forest./Fish.)	**9.6**	***13.6***	**9.6**	***13.5***	**6.3**	***13.2***	**-34.0**	**-34.0**	**5.9**	***13.4***	**-37.8**	**-37.8**	**5.8**	***14.0***	**-39.4**	**5.6**	***14.8***	**-40.9**	**5.5**	***14.8***	**-42.7**	**5.5**	***15.3***	**-42.3**
CO_2	9.4	*98.6*	9.4	*98.5*	6.2	*98.0*	-34.4	-34.4	5.8	*98.2*	-38.1	-38.0	5.7	*98.1*	-39.7	5.5	*98.1*	-41.2	5.4	*98.1*	-43.0	5.4	*98.1*	-42.6
Methane	0.0	*0.5*	0.0	*0.5*	0.1	*0.9*	21.7	15.3	0.0	*0.8*	2.4	-3.0	0.0	*0.8*	2.5	0.0	*0.8*	2.5	0.0	*0.8*	0.6	0.0	*0.8*	-1.1
Nitrous oxide	0.1	*0.9*	0.1	*0.9*	0.1	*1.1*	-21.0	-22.9	0.1	*1.0*	-30.8	-32.5	0.1	*1.1*	-30.7	0.1	*1.1*	-32.6	0.1	*1.1*	-34.5	0.1	*1.0*	-34.6
1A4b: "Households" (Residential)	**5.1**	***7.3***	**5.2**	***7.3***	**2.1**	***4.3***	**-60.1**	**-60.2**	**1.8**	***4.0***	**-65.8**	**-65.9**	**1.3**	***3.3***	**-73.8**	**1.1**	***2.9***	**-78.7**	**0.9**	***2.3***	**-83.4**	**0.8**	***2.1***	**-85.3**
CO_2	5.0	*97.0*	5.0	*97.1*	1.9	*91.9*	-62.2	-62.3	1.6	*91.4*	-67.8	-67.9	1.2	*90.4*	-75.6	1.0	*90.4*	-80.2	0.8	*90.6*	-84.5	0.7	*91.2*	-86.2
Methane	0.1	*2.4*	0.1	*2.3*	0.1	*5.1*	-13.8	-11.2	0.1	*5.3*	-24.3	-22.0	0.1	*5.7*	-37.2	0.1	*5.4*	-51.9	0.0	*4.9*	-65.9	0.0	*3.9*	-76.1
Nitrous oxide	0.0	*0.6*	0.0	*0.6*	0.1	*2.9*	89.4	88.8	0.1	*3.3*	85.8	85.2	0.1	*3.9*	68.1	0.0	*4.2*	45.4	0.0	*4.6*	23.2	0.0	*4.9*	16.6

FIGURE 4.8 DENMARK'S GREENHOUSE GAS EMISSIONS IN 2017 BY SECTOR

Source: Nielsen et al. (2019) and the Danish Ministry of Climate, Energy and Utilities



4.3.1 Allowance regulation - Emission Trading Scheme

EU ETS 2005-2007

Directive 2003/87/EC on trading in CO_2 allowances (the EU ETS Directive) in 2005 introduced a greenhouse gas emissions allowance trading scheme in the EU. The objective of the allowance scheme is to reduce emissions of greenhouse gases so that the EU and its Member States can meet their reductions commitments under the Kyoto Protocol and the EU Burden-Sharing Agreement.

EU ETS 2008-2012

According to the EU ETS Directive, each Member State had to prepare a national allocation plan before the trading period 2008-12.

The European Commission approved the Danish National Allocation Plan (NAP2) in 2007. The NAP contained a detailed plan for the reduction efforts. In the NAP, the gap between the emission target and emission under business as usual amounted to 13 million tonnes CO_2 per year. Of this gap, 5.2 million tonnes CO_2 are covered by efforts in the emission trading sector, while the remaining 7.8 million tonnes CO_2 are covered by efforts in the non-emission trading sector using various instruments, including the use of CDM credits, sinks and additional domestic efforts. The NAP also ensures that Denmark honours the supplementarity principle.

Via the NAP, the allowance regulation in Denmark included individual emission limits 2008-2012 for CO_2 emissions from several sectors, which together produce approx. half of Denmark's total greenhouse gas emissions. Denmark allocated a total of 125 million CO_2 emission allowances during the five years of the scheme. Of these, 2.5 million have been allocated to new production units and major expansions. The rest have been allocated free of charge to those production units covered by the trading scheme in 2007.

In the following, only the principles and general figures for Denmark's implementation of the EU ETS Directive via NAP2 will be described.

From the 1 January 2008 the first Kyoto Commitment Period (CP1) commenced. In practice the EU ETS has not changed for the Danish operators under the EU ETS, even after the Community Independent Transaction Log and the registries under the EU ETS connected to the International Transaction Log under the UN on 28 October 2008, as the registry was already ready to work in the international emissions trading system.

Relevant key figures in the NAP for Denmark for the period 2008 – 2012 are shown in Table 4.3.

TABLE 4.3: KEY FIGURES IN THE PROPOSAL FOR DENMARK'S NATIONAL ALLOCATION PLAN 2008-12
Source: Denmark's National Allocation Plan 2008-12 (NAP2), 2007

	2003 emissions	Projected emissions 2008-12	Quota allocation 2008-12	Quota allocation 2005-07
	Million tonnes CO_2 equivalents per year			
Sectors subject to allowances, in total	36.6	29.7	24.5	33.5
- electricity & heat production	28.1	20.5	15.8	21.7
- other sectors subject to allowances, incl. offshore industries-	8.5	9.2	8.2	7.1
- auction			0	1.7
- new installations			0.5	1
Sectors not subject to allowances	*37.8*[1]	*38.1*		
Total	74.4	67.8		

[1] On the basis of the European Commission's broad definition of enterprises covered.

Denmark was committed to reducing its national greenhouse gas emissions by 21% in 2008-12, compared to 1990/1995 level. That meant that emissions had to be reduced to an average 54.8 million tonnes of CO_2 equivalents annually for the period.

In NAP2, the deficit between expected Danish emissions of CO_2 and the target Denmark was committed to achieving was expected to 13 million tonnes for the period 2008-12 if no further initiatives were implemented. The NAP documented how this deficit would be reduced to zero. As stated in NAP2, Denmark would meet its commitment through a combination of domestic and foreign environmental and energy measures by the government and by Danish enterprises with CO_2 emissions.

Denmark has had an active, environmentally oriented energy policy since the 1970s, and since 1990 this has been supplemented by an actual climate policy which, on an international scale, has entailed a major strain - economically and/or via administrative regulations - on most greenhouse gas emissions, especially from businesses and sectors not subject to allowances.

The period 2008 – 2012 was finalized in 2013 with the final surrendering of allowances and credits by companies participating under the EU ETS.

The final EU ETS accounting in Denmark for the period 2008-2012 shows that total verified CO_2 emissions under the EU ETS in Denmark were a little below the total amount of allocated allowances cf. Table 4.4. However, some companies have to

some extent surrendered credits from JI and CDM projects and presumably instead sold or banked their surplus EU allowances.

TABLE 4.4: VERIFIED CO_2 EMISSIONS UNDER THE EU ETS IN DENMARK, FREE ALLOCATIONS AND SURPLUS/DEFICIT FOR THE PERIOD 2008-2012

Source: Danish Energy Agency, May 2013

	Verified CO_2 emissions under the EU ETS in Denmark 2008-2012						**Free allocation**	**Excess of quotas (negative number represents a deficit)**
	2008	2009	2010	2011	2012	Annual Average 2008-12	Annual Average 2008-12	Annual Average 2008-12
	Million tonnes CO_2						Million tonnes EUAs	Million tonnes EUAs
Central power plants	17.6	17.8	17.2	13.8	10.9	15.46	13.4	-2.06
Industry and Service	5.3	4.3	4.2	4.3	4.3	4.48	5.8	1.32
Offshore	2.0	1.8	1.9	1.7	1.7	1.82	2.3	0.48
Other electricity and heat production	1.6	1.6	2.0	1.6	1.4	1.64	2.4	0.76
Total stationary[1]	**26.5**	**25.5**	**25.3**	**21.5**	**18.2**	**23.4**	**23.9**	**0.5**
Aviation[2]			(1.5)	(1.4)	1.3	1.3	1.1	- 0.2

[1] In 2012, a total of 375 stationary installations were covered. Of these were 16 central power and heat plants, 111 manufacturing industries, 241 decentralized electricity and district heating plants and 7 offshore companies.

[2] In 2012, total CO_2 emissions from the 26 aircraft operators covered by the EU ETS in Denmark exceeded the free allocation of allowances for 2012. It should be noted that aviation emissions for 2012 cannot be compared with previous years, as aircraft operators in 2012 have been able to make use of the EU Commission's "stop- the-clock " decision. This decision, which applies only for 2012, gives an operator the opportunity to deduct CO_2 emissions related to flights in and out of the EU. Most operators chose to make use of this opportunity.

EU ETS 2013-2020

The EU Climate and Energy Agreement from December 2008 extended the ETS system to 2013-2020 in order for the EU to reduce CO_2-emissions by 20% in 2020. At the same time allocation was centralised and reduced, while auctioning is being/have been used more extensively since 2013.

Free allocation for stationary installations is carried out on the basis of benchmarks. These benchmarks reward best practice in low-emission production and are an important signal of the EU's commitment to moving towards a low-carbon economy.

Although auctioning is the default method for allocating emission allowances to companies participating in the EU ETS, the manufacturing industry continues to receive a share of free allowances until 2020 due to carbon leakage. The heat production also continues to receive free allowances – however declining from 80% of the benchmark in 2013 to 30% of the benchmark in 2020 for those not being exposed to carbon leakage.

The allowances for the installations in the EU ETS have been calculated for 2013-2020 in accordance with the EU benchmarking decision 2011/278/EU. The Danish National Implementation Measures (NIM) list was approved by the European Commission in January 2014.

Waste incineration plants which are primarily used for district heating were included in the ETS in Denmark by 1st of January 2013, while about 30 installations exclusively using biomass were excluded of the ETS. The inclusion of waste incineration plants lead to an increase in the total amount of CO_2-emission from the ETS in Denmark in 2013 compared to 2012.

Aviation has been a part of ETS since 2012. Aircraft operators get free allowances based on their activity and the scope.

EU ETS 2021-2030

The legislative framework of the EU ETS for its next trading period 2021-2030 (phase 4) was revised in early 2018 to enable it to achieve the EU's 2030 emission reduction targets in line with the 2030 climate and energy policy framework and as part of the EU's contribution to the 2015 Paris Agreement.

The revision focuses on:

- Strengthening the EU ETS as an investment driver by increasing the pace of annual reductions in allowances to 2.2% as of 2021 and reinforcing the Market Stability Reserve (the mechanism established by the EU in 2015 to reduce the surplus of emission allowances in the carbon market and to improve the EU ETS's resilience to future shocks).
- Continuing the free allocation of allowances as a safeguard for the international competitiveness of industrial sectors at risk of carbon leakage, while ensuring that the rules for determining free allocation are focused and reflect technological progress.
- Helping industry and the power sector to meet the innovation and investment challenges of the low-carbon transition via several low-carbon funding mechanisms.

Denmark's national allowance registry

Denmark's national allowance registry – (DK ETR – Emission Trading Registry[12]) has been operating since 1 January 2005. The DK ETR is used to allocate allowances to production facilities subject to allowances and enables trade in allowances among the allowance holders found in the registry. Since the 1st of July 2012 the DK ETR has been a part of the EU ETS that host the emission trading registry for all of the member states in the EU. The DK ETR is constructed so it also fulfils all Kyoto requirements.

The DK ETR is also functioning as the national registry under the Kyoto Protocol. The establishment of a functioning DK ETR pursuant to the Kyoto Protocol is a prerequisite for the application of the Kyoto mechanisms.

4.3.2 The Kyoto Protocol mechanisms

For the period 2008-2012, the flexible Kyoto Protocol mechanisms have been important elements in supplementing domestic reduction measures aimed at fulfilling

[12] https://www.kvoteregister.dk

the international climate commitment under the Kyoto Protocol and the subsequent EU Burden Sharing Agreement.

For the period 2013-2020, the government will not use the flexible Kyoto Protocol mechanisms for the achievement of Denmark's target under the EU Effort Sharing Decision, which is to be seen as Denmark's contribution to the EU joint target under the 2nd commitment period of the Kyoto Protocol. For the achievement of the joint EU target for the EU Emissions Trading Scheme's contribution to the EU joint overall target under the 2nd commitment period of the Kyoto Protocol, Danish entities under the EU ETS will be able to make use of the flexible Kyoto Protocol mechanisms subject to the conditions in the EU legislation. In the ETS, the use of international credits is capped (up to 50 % of the reduction required from EU ETS sectors by 2020). Quality standards also apply to the use of international credits in the EU ETS, including a ban on credits from LULUCF projects and certain industrial gas projects.

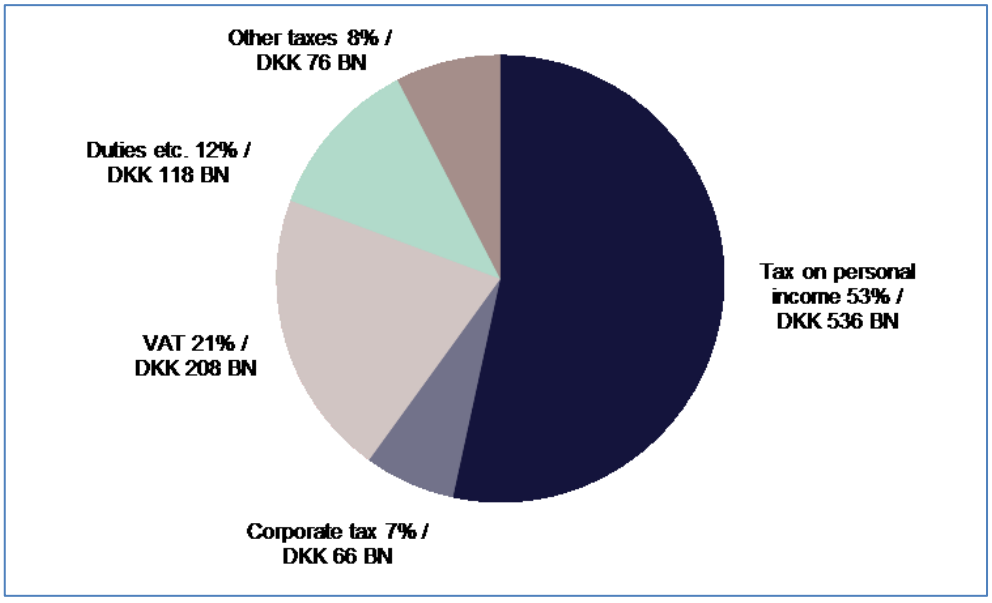
4.3.3 Taxes and duties

In Denmark, total taxes and duties made up a total of approx. 46% of GDP in 2017. The public sector provides childcare, education, unemployment benefits, health and disability benefits, old-age pensions, and many other services.

Personal income tax is the most important tax, constituting about half of total tax revenues. Other taxes are VAT, duties and corporation taxes. Danish VAT is relatively high, 25%, and there are no differentiated rates. There are a considerable number of additional consumption taxes and environmental taxes. The corporation tax rate is 22%.

Total revenue from all taxes and duties amounted to DKK 1,003 billion in 2017. The relative distribution is shown in Figure 4.9.

FIGURE 4.9 RELATIVE DISTRIBUTIONS OF TAXES AND DUTIES 2017
Source: Ministry of Taxation, Statistics Denmark



Taxes that influence Denmark's greenhouse gas emissions

Retail prices on products that influence Danish greenhouse gas emissions are, in most cases, the decisive factor determining the degree to which they are consumed. Energy prices influence the composition and total size of energy consumption. Therefore extra taxes and duties put on products influence the consumption of these products and the size of greenhouse gas emissions associated with the use of the products.

Denmark has special taxes on motor vehicles, energy products, alcohol, tobacco, and a number of other products. During the past 25 years a number of new environmental taxes have been introduced. These taxes are imposed on consumer goods that cause pollution or are scarce (water, energy products such as oil, petrol, electricity, etc.) or on discharges of polluting substances (CO_2, HFCs, PVC, SF_6, SO_2, NO_x and sewage). Taxes are in accordance with EU legislation.

The introduction of CO_2 taxes and the increase in the rates of individual energy taxes since 1990 have had an effect on the consumption of a number of energy products and have therefore reduced the CO_2 emissions associated with consumption of these products.

4.3.3.1 ***CO_2, CH_4, and N_2O - taxes and duties relevant to these emissions***

4.3.3.1.1 Energy

Denmark has had taxes on energy for many years. Since the first oil crisis in the early 1970s, the rates of the taxes have been aimed at reducing consumption and promoting the instigation of more energy-saving measures. Lower energy consumption will reduce emissions of CO_2, methane (CH_4), and nitrous oxide (N_2O) associated with combustion of fossil fuels.

Danish energy taxes are laid down in the four Danish tax acts on mineral-oil, gas, coal, and electricity, respectively (Mineralolieafgiftsloven, Gasafgiftsloven, Kulafgiftsloven, and Elafgiftsloven). Besides the energy taxes there is also a tax on CO_2, NO_x, sulphur and industrial gasses (see Table 4.5). As from 1 January 2016 the tax rates set in these tax acts follow a yearly regulation based on the consumer price index of two years prior except for the tax rates on industrial gasses.

A tax on NO_x (nitrogen oxides) was originally introduced as part of a 2008 energy agreement and came into effect on 1 January 2010 with a rate of 5 DKK per kg NOx. From 1 January 2012, a considerable increase in the taxation of NOx from 5 DKK per kg NOx to 25 DKK per kg NOx was implemented. However, the rate was reduced in 2016 to 5 DKK per kg NOx.

A tax on sulphur in fuels was introduced 1 January 1996 with a rate of 20 DKK per kg sulphur in fuels and a rate of 10 DKK for SO_2 emitted to the air. One of the side effects of this tax is assumed to be a reduction in CO_2 emissions.

In March 2012 a general agreement on Danish energy policy from 2012-2020 was made. The agreement seeks to ensure the transition from an energy supply based on fossil fuels to one based on renewable energy. Additional initiatives regarding taxes and duties have been adopted with the 2018 Energy Agreement and planned with the 2018 Climate and Air proposal. These initiatives are described later.

TABLE 4.5 ENERGY TAXES 2010-2018

Source: Ministry of Taxation

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018
Coal	*DKK/toe*	2,399	2,445	2,487	2,533	3,006	2,282	2,299	2,315	2,324
Natural gas	*DKK/toe*	2,405	2,449	2,493	2,538	3,006	2,282	2,299	2,315	2,324
Oil products[1]	*DKK/toe*	2,400	2,443	2,487	2,532	3,009	2,282	2,299	2,315	2,314
Electricity: For heating	*DKK/kWh*	0.545	0.614	0.624	0.341	0.412	0.380	0.383	0.405	0.257[3]
Electricity: Other	*DKK/kWh*	0.659	0.730	0.742	0.755	0.833	0.878	0.885	0.910	0.914
Waste: Heating from waste	*DKK/toe*	1,930	2,035[2]	2,072	2,110	2,504	1,901	1,918	1,926	1,938
Other compostable biomass	*DKK/toe*	0	0	0	0	0	0	0	0	0

[1]Only oil used for other purposes than motor fuels
[2]From 1 January 2011 – 30 June 2011 the rate was 1955.2 DKK/toe, where toe is the energy unit "tonnes oil equivalents".
[3]From 1 January 2018 – 30 April 2018 the rate was 0.407 DKK/kWh.

The Mineral-oil Tax Act entered into force on 1 January 1993. Before this, the tax on petrol was regulated via the Petrol Tax Act, which entered into force on 1 January 1983, and the Act on Taxation of Gas Oil and Diesel Oil, Heating Oil, Heating Tar, and Crude Oil was regulated via the Act on Taxation of certain Oil Products, which entered into force on 3 October 1977. Tax rates from recent years are shown in Table 4.6.

TABLE 4.6 TRENDS IN TAXES 2010-2018 UNDER THE MINERAL-OIL TAX ACT, STATED IN DKK/LITRE

Source: Ministry of Taxation

DKK per litre	2010	2011	01.01.12-30.06.12	01.07.12-31.12.12	2013	2014	2015	2016	2017	2018
Gas oil and diesel oil used as motor fuels	2.774	2.825	2.876	2.840	2.891	2.944	2.997	3.021	3.039	3.054
Light diesel oil	2.669	2.718	2.767	2.731	2.780	2.830	2.881	2.904	2.921	2.936
Diesel low in sulphur content	2.479	2.524	2.570	2.534	2.579	2.626	2.674	2.695	2.711	2.725
Diesel without sulphur	2.479	2.524	2.570	2.534	2.579	2.626	2.674	2.695	2.711	2.725
Fuel oil	2.330	2.372	2.415	2.415	2.835[1]	2.921	2.215	2.233	2.246	2.257
Auto gas	1.726	1.757	1.788	1.719	1.749	1.782	1.814	1.829	1.839	1.848

[1] In January 2013, the rate was 2.458, and from February to December the rate was 2.869.

From 1 June 1999 a tax differentiation between light diesel and diesel low in sulphur was introduced, to encourage the use of diesel low in sulphur, which is less polluting than light diesel. This was accomplished and a change took place soon after to the effect that almost all diesel sold was low in sulphur. The purpose of further differentiation from 1 January 2005 favouring sulphur-free diesel was likewise to encourage the use of this type of diesel in favour of diesel low in sulphur, and this has been successful.

In addition, tax differentiation has been introduced in order to achieve environmental goals other than direct reductions in greenhouse gas emissions. Thus tax differentiation has been introduced with a view to phasing out lead in petrol. The rate of tax to achieve this environmental goal is shown in Table 4.7.

TABLE 4.7 TRENDS IN TAXES ON DIFFERENT TYPES OF PETROL 2010-2018, DKK PER LITRE
Source: Ministry of Taxation

DKK per litre	2010	2011	2012	2013	2014	2015	2016	2017	2018
Petrol, with lead	4.567	4.649	4.733 / 4.700	4.785	4.871	4.959	4.999	5.028	5.053
Petrol, lead-free	3.881	3.951	4.022 / 3.989	4.062	4.134	4.209	4.243	4.268	4.289

[1] The term has been kept even though petrol companies in Denmark ceased using lead for octane improvement in 1994.

The gas tax on natural and town gas was introduced in its current form on 1 January 1996 with a rate for both natural and town gas at DKK 0.01/Nm^3. There has been taxation on gas, however, since 1 January 1979, when the tax on town gas and LPG was introduced. The tax on town gas was cancelled again in June 1983 and regulation of the tax on LPG was transferred to the Mineral-gas Tax Act when this Act entered into force. From 1 January 2015 a tax on biogas was introduced. The tax rates on gas from recent years are shown in Table 4.8.

TABLE 4.8 TAXES ON GAS 2010-2018, DKK PER NM^3
Source: Ministry of Taxation

DKK per Nm^3	2010	2011	2012	2013	2014	2015	2016	2017	2018
Natural gas	2.270	2.311	2.353	2.395	2.438	2.158	2.175	2.188	2.199
Town gas	2.270	2.311	2.353	2.395	2.438	2.158	2.175	2.188	2.199

The coal tax was introduced on 1 July 1982 and constituted DKK 127/tonne for hard coal and DKK 91/tonne for lignite and lignite briquettes on the day of entry into force. In the period 1 January 1997 - 31 December 2015 the tax increased from DKK 950/tonne to DKK 1526/tonne for hard coal and DKK 700/tonne to DKK 1036/tonne lignite. The rates have since 2008 developed as shown in Table 4.9. With effect from 1 January 1999, the so-called waste heat tax introduced (see Law no. 437 of 26 June 1998) as part of the Coal Tax Act. The waste heat tax was introduced in connection with increases in general taxes on fossil fuels to avoid giving too much incentive in favour of waste-based heat production, and to counteract the increased incentive for incineration of waste instead of recycling. From 1 January 2010 the tax was by burning waste converted from an amount of tax to a tax on energy and CO_2.

Restructuring the waste incineration tax is no longer collected by Waste Tax Act, but is transferred to the Coal Tax and carbon dioxide tax law (see Law no. 461 of 12 June 2009 and the entry into force of Executive Order no. 1125 of 1 December 2009). Context of the proposal was especially that the then tax structure for waste fuels and fossil fuels taken together could result in waste streams are affected, so waste is not disposed of where it was most effective with regard to utilization of the waste energy. The purpose of the change was to make waste more cost-efficient, which means a welfare economic gain. The change improves the tax structure, because the waste now ordered virtually the same charges as fossil fuels. The restructuring charges will then be more neutral with respect to where the waste is burned. From 1 January 2010, energy from waste incineration imposed waste heat tax, surcharge and the CO_2 tax. CO_2 tax only if the waste is not biodegradable.

TABLE 4.9 TRENDS IN COAL TAXES 2010-2018, DKK PER TONNE
Source: Ministry of Taxation

DKK per tonne	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hard coal	1605	1634	1663	1693	2012	1526	1538	1547	1555
Lignite	1089	1109	1129	1149	1365	1036	1044	1051	1056

The electricity tax was introduced on 1 April 1977. With effect from 1 January 2013, the tax on electricity used for heating was reduced considerably, to take into account, that an increasing amount of renewable energy was being used in electricity production. It has been estimated that this will lead to an emission reduction outside the emissions trading scheme of 0.15 million tonnes CO_2 in 2015 and 0.29 million tonnes in 2018. Table 4.10 shows the development in electricity tax rates since 2010.

From 1 May 2018 until the end of 2019 the tax on electricity for heating is further reduced from DKK 0.407 per kWh by DKK 0.15 per kWh. In 2020 it is reduced by DKK 0.20 per kWh and from 2021 it is reduced by DKK 0.10 per kWh from 2021.

Further tax reductions on electricity are agreed with the 2018 Energy Agreement:

- The electrical heating tax will be reduced from 0.307 DKK/kWh to 0.155 DKK/kWh, effective 2021.

- The electricity tax will be reduced from 0.914 DKK/kWh to 0.774 DKK/kWh (phased in from 2019-2025).

- The electricity tax for certain liberal professions will be reduced from 0.914 DKK/kWh to 0.004 DKK/kWh in 2023. This implies that these liberal professions from 2023 will pay the same taxrate as other VAT-registered business.

TABLE 4.10 TRENDS IN ELECTRICITY TAXES 2010-2018, DKK PER KWH

Source: Ministry of Taxation

DKK per kWh	2010	2011	2012	2013	2014	2015	2016	2017	2018
Consumption of electricity, exceeding 4,000 kWh in all-year residences heated by electricity and electricity for space heating and comfort cooling in VAT registered business	0.545	0.614	0.624	0.341	0.412	0.380	0.383	0.405	0.257[1]
Other electricity	0.659	0.730	0.742	0.755	0.833	0.878	0.885	0.910	0.914

[1]From 1 January 2018 – 30 April 2018 the rate was 0.407 DKK/kWh.

The CO_2 tax on energy products was introduced on 1 March 1992 and was imposed on different types of energy products relative to their CO_2 emissions. A tax reduction was given to light and heavy industrial processes. From 1 January 2010 a structural change in the CO_2 tax was implemented as an adaption to the EU Emissions Trading Scheme. The tax rate was increased to DKK 150 /tonne of CO_2 indexed as mentioned below, cf. table 4.11. In total, this structural change in the CO_2 tax was estimated to lead to a reduction in the CO_2 emissions of 0.69 million tonnes.

Large waste incineration facilities are from 1 January 2013 included in the emissions trading scheme. This will lead to a reduction of CO_2 emissions outside the ETS of approximately 8.9 million tonnes.

Fossil energy products used for space heating are imposed the CO_2 tax regardless of the production is included in the ETS or not. Space heating included in the emission trading scheme is thus double taxed.

TABLE 4.11 CO_2 TAX RATES, 2000-2018, STATED IN DKK PER TONNE OF CO_2

Source: Ministry of Taxation

DKK per tonne	2000-2004	2005-2009	2010[1]	2011	2012	2013	2014	2015	2016	2017	2018
Basic rate											
Heating in industry	100	90	155.4	158.2	161.1	164.0	166.9	170.0	171.4	172.4	173.2
Light industrial processes											
Basic rate	90	90	-	-	-	-	-	-	-	-	
With a voluntary agreement	68	68	-	-	-	-	-	-	-	-	
Resulting subsidy	22	22	-	-	-	-	-	-	-	-	
Heavy industrial processes											
Basic rate	25	25	-	-	-	-	-	-	-	-	
With a voluntary agreement	3	3	-	-	-	-	-	-	-	-	
Resulting subsidy	22	22	-	-	-	-	-	-	-	-	
Industrial processes covered by the Emission Trading Scheme											
Basic rate [2]	-	-	0	0	0	0	0	0	0	0	

[1] As of 1 January 2010 a structural change in the CO_2 tax was implemented. For the industries not regulated by the emissions trading scheme, a fixed lump sum transfer based on historical emissions was given, while the base rate was considerably increased to match the expected price of CO_2 quotas.

[2]Before 2010, the industrial processes covered by the ETS were taxed according to the table, depending on the type of process

Table 4.12 shows examples of the different types of CO_2 taxes converted into consumer units.

TABLE 4.12 EXAMPLES OF CO_2 TAXES

Source: Ministry of Taxation

	Unit	2010	2011	2012	2013	2014	2015	2016	2017	2018
Gas oil and diesel oil	*DKK/litre*	0.413	0.420	0.428	0.435	0.443	0.451	0.455	0.457	0.460
Gas oil and diesel oil containing 4,8% bio fuel	*DKK/litre*	0.385	0.391	0.399	0.405	0.413	0.420	0.423	0.426	0.428
Fuel oil	*DKK/kg*	0.493	0.502	0.511	0.520	0.529	0.539	0.543	0.547	0.549
Lignite	*DKK/tonne*	225.8	225.9	225.10	225.11	301.3	306.8	309.8	311.1	312.6
Natural gas and town gas	*DKK/Nm³*	0.351	0.357	0.364	0.370	0.377	0.384	0.387	0.389	0.391
Petrol	*DKK/litre*	0.373	0.379	0.386	0.393	0.400	0.408	0.411	0.414	0.416
Petrol containing 4,8% bio fuel	*DKK/litre*	0.355	0.361	0.367	0.374	0.381	0.388	0.391	0.393	0.395

In addition to this, there are CO_2 taxes on heating tar, crude oil, coke, crude oil coke, lignite briquettes and lignite, LPG, and other gases.

As of 1 January 2008 the CO_2 taxes follow a yearly regulation of 1.8% in the period 2008-2015, similar to the energy taxes. From 2016 the tax is regulated with the consumer price index two years prior as the energy taxes.

4.3.3.1.2 Transport

In the transport sector, the number of cars in Denmark and the use of motorised vehicles are influenced by the tax on cars and fuels. The latter has been described above.

The registration tax on motorised vehicles is calculated on basis of the value of the vehicle. It is furthermore integrated in the design of the registration tax that cars are granted deductions in the registration tax with reference to their specific energy efficiency and safety equipment. Cars with high energy efficiencies, such as electric vehicles, are granted large reductions in the registration tax. Passenger cars, light commercial vehicles and motorbikes are due to pay the registration tax.

The registration tax on electric vehicles is gradually introduced annually until 2023 when it is fully phased in. Furthermore a deduction dependant on battery capacity is given during the phase-in scheme. There is also a tax base deduction for electric and plug-in hybrid cars that amount to DKK 40,000 in 2019 and DKK 77,500 in 2020.In total, this means that electric cars with a value of up to DKK 400,000 (including VAT) currently on the Danish market will pay DKK 0 in registration tax in 2019 and 2020 and a low registration tax for more expensive electric vehicles. In addition, the part of the registration tax that will be phased in for plug-in hybrid cars, will be DKK 0 in 2019 and 2020 for most of the plug-in hybrid cars on the Danish market today.

Car owners have to pay half-yearly ownership taxes which are differentiated in accordance with the fuel efficiency of the cars, expressed in kilometres per litre. The energy consumption of electric cars is converted to a petrol fuel efficiency on the basis of the energy content of petrol. Examples of classes from 2018 for passenger cars are shown in Table 4.13.A and 4.13.B. From July the 1st 2018 the owner ship tax for cars registered in Denmark from October 3th 2017 is increased by 250 DKK half-yearly and there is introduced new classes in the ownership tax for the most energy efficient cars.

Hydrogen cars are not subject to registration tax nor ownership taxes before 2022. From 2022 there is a phase-in scheme of registration tax in 2022-2025 similar to the phase-in scheme for electric cars.

TABLE 4.13.A EXAMPLES FROM THE DANISH STRUCTURE OF TAX INCENTIVES BASED ON ANNUAL TAXES ON MOTOR VEHICLES REGISTRATED IN DENMARK BEFORE 3 OCTOBER 2017 (2018), DKK/YEAR
Source: Ministry of Taxation

Type of fuel	Fuel consumption (km/l)	Annual tax (DKK/year)
Petrol	**> 19.9**	660
	10.0 – 10.4	6,820
	< 4.5	22,860
Diesel	**> 32.0**	260
	28.1-32.0	1,200
	25-28.0	2,120
	22.5 - 24.9	2,980
	10.2 – 11.2	13,060
	< 5.1	33,440

TABLE 4.13.B EXAMPLES FROM THE DANISH STRUCTURE OF TAX INCENTIVES BASED ON ANNUAL TAXES ON MOTOR VEHICLES REGISTRATED IN DENMARK FROM 3 OCTOBER 2017 (FROM 1 JULY 2018), DKK/YEAR
Source: Ministry of Taxation

Type of fuel	Fuel consumption (km/l)	Annual tax (DKK/year)
Petrol	**> 49.9**	660
	44.4 – 49.9	740
	33.3-36.3	860
	25.0-28.5	1,000
	22.2-24.9	1,080
	16.7-18.1	2,380
	< 4.5	23,360
Diesel	**> 56.2**	920
	50-56.2	1,000
	37.6-40.9	1,120
	28.1-32.0	2,200
	20.5-22.4	4,320
	10.2 – 11.2	13,560
	< 5.1	33,940

4.3.3.1.3 The household sector

For the household sector, the taxes levied on consumption of electricity and heat affect consumption figures, since these products become more expensive with the introduction of taxes.

*4.3.3.2 **HFCs, PFCs, and SF_6 - taxes and duties relevant to these emissions***

Since 1 March 2001, imports of industrial gases HFCs, PFCs, and SF_6 (F-gases) in the industry/business sector have been subject to taxation. The tax is differentiated in accordance with the global warming potential of the substance with DKK 0.15 per kilogramme of CO_2 equivalents as the general principle and with DKK 600 per kilogramme as a general upper limit cf. the examples in Table 4.14.

As the taxes on industrial gases are based on the CO_2 tax, there was an increase in 2011, from DKK 0.10 per kilogramme of CO_2 equivalents to DKK 0.15, following the increased CO_2 tax rate shown in Table 4.11. The impact of this increase is expected to lead to a reduction in the emission of the industrial gasses of 0.02 million tonnes CO_2 equivalents.

TABLE 4.14 EXAMPLES OF TAXES ON F-GASES, 2018
Source: Ministry of Taxation

Substance	GWP	Tax in DKK per kg
HFC-134a	**1430**	215
R404a (a combination of 3 HFCs)	**3922**	588
SF_6	**22800**	600

*4.3.3.3 **Tax on methane emissions from natural gas fired power plants - equal in terms of CO_2 equivalents to the CO_2 tax.***

As of 1 January 2011 a tax on methane emissions - equal in terms of CO_2 equivalents to the CO_2 tax - from natural gas fired power plants was introduced. This is expected to reduce methane emissions from gas engines through behavioural changes such as changing from motor operation to boiler operation and establishing mitigation measures. Consumption is also expected to fall as the price of heat will increase. These behavioural changes will result in falls in the emissions of unburned methane from power stations. In addition, CO_2 emissions will fall and consumption of natural gas will fall. In total, a decline of 0.06 million tonnes CO_2 equivalent emissions in 2 out of 5 years is expected, corresponding to an average annual reduction effect of approximately 0.02 million tonnes CO_2 equivalent per year in 2008-12.

Table 4.15[17] contains an overview of all existing taxes and duties relevant to greenhouse gas emissions in Denmark.

TABLE 4.15 OVERVIEW OF TAX AND DUTY MEASURES

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
TD-1b: Mineral-oil Tax Act	Yes*	Energy, Transport	CO2, CH4, N2O	Demand management/reduction (Energy consumption)	Economic, Fiscal	Implemented	See text.	1993	Government: Ministry of Taxation	1200 and IE(G1 and G4)	1200 and IE(G1 and G4)	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Denmark's 7th National Communication, Annex B2)).
TD-2: Gas Tax Act	Yes*	Energy	CO2, CH4, N2O	Demand management/reduction (Energy consumption)	Economic, Fiscal	Implemented	See text.	1996	Government: Ministry of Taxation	IE (G1, G2 and G4)	IE (G1, G2 and G4)	
TD-3: Coal Tax Act	Yes*	Energy	CO2, CH4, N2O	Demand management/reduction (Energy consumption)	Economic, Fiscal	Implemented	See text.	1982	Government: Ministry of Taxation	IE (G1, G2 and G4)	IE (G1, G2 and G4)	
TD-4: Electricity Tax	Yes*	Energy	CO2, CH4, N2O	Demand management/reduction (Energy consumption)	Economic, Fiscal	Implemented	See text.	1977	Government: Ministry of Taxation	IE (G1, G2 and G4)	IE (G1, G2 and G4)	
TD-5: CO2 tax on energy products	Yes*	Energy	CO2	Demand management/reduction (Energy consumption)	Economic, Fiscal	Implemented	See text.	1992	Government: Ministry of Taxation	410 and IE (G1 and G4)	410 and IE (G1 and G4)	
TD-6: Green Owner Tax - a fuel-efficiency-dependent annual tax on motor vehicles	Yes*	Transport	CO2, CH4, N2O	Demand management/reduction (Energy consumption), Low carbon fuels/electric cars (Transport)	Economic, Fiscal	Implemented	See text.	1997	Government: Ministry of Taxation	IE (G1, G4 and G5)	IE (G1, G4 and G5)	
TD-7: Registration Tax - a fuel-efficiency-dependant registration tax on passenger cars and vans	Yes*	Transport	CO2, CH4, N2O	Demand management/reduction (Energy consumption), Low carbon fuels/electric cars (Transport)	Economic, Fiscal	Implemented	See text.	2000	Government: Ministry of Taxation	IE (G1 and G4)	IE (G1 and G4)	
TD-8: Tax on HFCs, PFCs and SF6 - equivalent to the CO2 tax	Yes*	Transport	HFCs, PFCs, SF6	Reduction of emissions of fluorinated gases (Industrial processes)	Economic, Fiscal	Implemented	See text.	2001	Government: Ministry of Taxation	IE (G1 and G6)	IE (G1 and G6)	
TD-9: Tax on methane from natural gas fired power plants - equivalent to the CO2 tax	Yes*	Energy	CH4, CO2	Reduction of losses (Energy supply), Control of fugitive emissions from energy production (Energy supply), Methane reduction ()	Economic, Fiscal	Implemented	See text.	2011	Government: Ministry of Taxation	30	30	Estimates in 2017 - based on The 2013 Analysis of the Effects of Selected Measures for the National Audit Office, Danish Energy Agency, December 2013 (http://www.ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/kyoto-samlenotat_9._december.pdf (an English translation is included in Denmark's 7th National Communication, Annex B3))
G2(former TD-1a): Energy taxes except on mineral oil	Yes*	Combined (TD-2, TD-3 and TD-4)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	1000	1000	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Denmark's 7th National Communication, Annex B2)).

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.4 The National Green Climate Fund

In connection with the PSO Agreement of 2016 a majority of political parties in the Danish parliament decided to allocate funds to a national green climate fund. The fund is targeted initiatives accross all sectors that promote the green transition in an appropriate manner, including in particular initiatives that can contribute to the to the achievement of Denmark's 2030 greenhouse gas emission reduction target in the non-ETS sector, etc. The total budget for the fund is DKK 375 million for the period 2017-2020 - with DKK 50 million in 2017, DKK 50 million in 2018, DKK 100 million in 2019 and DKK 175 million in 2020.

In June 2017, the 1st allocation of the budget was decided. From the budget for 2017, 2018 and partially 2019 a total of DKK 104-106 million has been allocated for the initiatives mentioned in Table 4.16. A short description of the initiatives is included below.

The estimated greenhouse gas emission reduction effect of these initiatives is in total up to 56,000 tonnes of CO_2 eq. annually in the period 2021-2030.

TABLE 4.16 OVERVIEW OF THE INITIATIVES IN THE 1ST ALLOCATION OF FUNDS IN THE NATIONAL GREEN CLIMATE FUND

DKK million	***2017***	***2018***	***2019***	***2020***
Annual budget	**50**	**50**	**100**	**175**
Measures in the district heating sector				
1.1 Establishment grants for electric heat pumps on non-ETS cogeneration plants	23.9	28.9	-	-
1.2 Mapping and advisory efforts for decentralized CHP plants	4.0	6.0	4.0	-
Other actions				
2. Recycling system for flammable refrigerants	2.5	-	-	-
3. Reduced retention time for slurry in stables	0.0	9.0	-	-
4. Climate-friendly road surface	0.6	3.1	-	-
5. Demonstration project - bio refinery plant	8.0	-	-	-
6. Measurement of nitrous oxide from wastewater	-	3.0	2.0	-
7. Heat pumps on subscription for the business sector	11.0	-	-	-
Total 1st allocation	**50.0**	**50.0**	**6.0**	**-**

1.1 Establishment grants for electric heat pumps on non-ETS cogeneration plants

For the purpose of promoting heat pumps, a temporary pool is set up for collective heat pumps at non-ETS cogeneration plants. The scheme includes heat pumps that utilize different heat sources, including surplus heat, heat from wastewater treatment plants, etc. The support will ensure a good framework for choosing heat pumps.

1.2 Mapping and advisory efforts for decentralized CHP plants

A targeted advisory scheme for decentralized CHP plants is introduced within and outside the ETS sector. The advice includes technical, administrative, financial and financial matters. The scheme shall include identification of concrete actions at the plants that can lower the heat price for consumers and greenhouse gas emissions from heat production. The technical efficiency improvements of the CHP plants are expected to lead to CO2 reductions in the sector.

2. Recycling system for flammable refrigerants

Funds are set aside for establishing a recycling system for climate-friendly but flammable refrigerants in cooperation with the refrigeration industry. In general, for fluorinated refrigerants, the more climate-friendly they are (low GWP), the greater flammability. With the establishment of a new recycling system, a significant barrier for the wider and accelerated use of climate friendly, but flammable, refrigerants is eliminated.

3. Reduced retention time for slurry in stables

Funds are allocated for a travel team that can support the 27 existing biogas joint facilities to conduct further investigations of barriers, development of solutions with more frequent collection of slurry from suppliers, as well as information / advice to suppliers regarding the importance of frequent collection in order to utilize the gas potential of the slurry. Biogas plants are generally expected to be of great interest in getting the slurry faster for degassing as it will provide a larger amount of gas with the same amount of slurry.

4. Climate-friendly road surface

A demonstration road with climate-friendly road surface / asphalt is set up with the aim of obtaining final clarity regarding laying techniques, durability and functional properties. In addition to delivering concrete reductions, the demonstration project will ensure that material selection and evaluation techniques have been tested and optimized in a real production environment.

5. Demonstration project - bio refinery plant

A pool will be allocated for targeted support for projects concerning establishment of a green bio refinery pilot plant. The establishment of a pilot plant for bio refining of green biomass can promote the use of agricultural crops with more positive climate and environmental impacts than, for example, grain crops. Bio refining of clover grass can produce a pulp for biogas, press cakes for cattle feed and protein concentrate for fodder products. The purpose of the pilot plant is to qualify, optimize and demonstrate the technology. The objectives are to reduce the technology costs, create a market segment and to map expected effects and side effects.

6. Measurement of nitrous oxide from wastewater

A prerequisite for reducing the emission of nitrous oxide from wastewater treatment plants is more accurate knowledge of the processes that lead to nitrous oxide formation. A pool is therefore established for tests on the measurement and regulation of nitrous oxide at the wastewater treatment plants. The purpose of the project is to 1) improve the accuracy of the national greenhouse gas emission inventories, 2) establish the basis for more accurate shadow price calculations for reduction measures in the area, 3) provide a basis for reducing nitrous oxide emissions from wastewater treatment plants that receive means for measuring and regulating nitrous oxide emissions as well as in other Danish wastewater treatment plants.

7. Heat pumps on subscription for the business sector

A pool is being established to support the purchase of a number of heat pumps by a number of energy service companies that they install with their customers. It is expected that the scheme will lead to a large number of conversions from oil furnaces to heat pumps in the business sector during the next 4 years. It is also expected that the initiative could initiate a commercial market for fossil fuel conversion at companies.

In November 2017, the 2nd allocation of the budget was decided with the Agreement on Business and Entrepreneurship Agreement. From the budget for 2019 and 2020 a total of DKK 242,3 million has been allocated for lowering the electric heating tax cf. Table 4.17 (initiative no. 8). A short description of the initiative is included below.

TABLE 4.17 OVERVIEW OF THE INITIATIVE IN THE 2ND ALLOCATION OF FUNDS IN THE NATIONAL GREEN CLIMATE FUND

DKK million	*2017*	*2018*	*2019*	*2020*
Annual budget			**100,0**	**175,0**
1.2 Mapping and advisory efforts for decentralized CHP plants			4,0	
6. Measurement of nitrous oxide from wastewater			2,0	
8. Lower electric heating tax			67,3	175,0
Total 2nd allocation			**67,3**	**175,0**

Note: 2019 prices, including costs of administration

8. Lower electric heating tax

Reducing the electricity heating tax increases the incentive to use electric heat pumps, etc. in district heating production as well as in households and in business. It will also increase the incentive to use surplus heat. Reducing the electric heating charge will thus promote electrification in the heat supply and strengthen the green conversion. The parties to the Agreement on Business and Entrepreneurship agreed to reduce the electricity heating tax by an additional DKK 0.05 per kWh in 2019 and DKK 0.1 per kWh in 2020 funded by the funds allocated for the National Green Climate Fund.

In May 2019, the 3rd allocation of the budget was decided. Following the agreement on allocation of funds from June 2017 and the allocation of funds in connection with the Agreement on Business and Entrepreneurship Agreement in November 2017, there was DKK 26.7 million left to be allocated in 2019. As agreed in May 2019, a total of DKK 26.7 million has been allocated for the initiatives mentioned in Table 4.18. A short description of each initiative is included below.

TABLE 4.18 OVERVIEW OF THE INITIATIVES IN THE 3RD ALLOCATION OF FUNDS IN THE NATIONAL GREEN CLIMATE FUND

DKK million	*2017*	*2018*	*2019*	*2020*
Annual budget			**26.7**	-
9. GHG accounting and awareness building at farm-level			7.7	-
10. Climate-friendly feed production			2.0	-
11. Promotion of green biorefining			14.0	-
12. Promoting climate-friendly construction			3.0	-
Total 2nd allocation			**26.7**	**-**

Note: 2019 prices, including costs of administration

9. Greenhouse gas accounting and awareness building at farm-level
There is a need to strengthen the individual farmer's knowledge of the climatic consequences of their production. Furthermore, provide them with some management tools to be able to plan their agricultural operation more climate-friendly. Therefore, an initiative is initiated to develop a concept for greenhouse gas accounting at the farm-level as well as an advisory concept in relation to climate-friendly production.

10. Climate-friendly feed production
Danish agriculture largely imports feed from abroad. Production and transport of these results in emissions of greenhouse gas. Increased production of grass protein in Denmark can help reduce greenhouse gas emissions and at the same time have a positive climate effect in Denmark, if cultivation of grass replaces the production of maize and grain. Therefore, an experiment is initiated on climate-friendly feed production, which will help to develop a Danish production of climate-friendly feed.

11. Promotion of green biorefining
Continued development of biorefining can help increase the demand for grass, which is a more environment- and climate-friendly crop than an annual grain crop. In order to make grass an attractive and competitive crop, the subsidy framework is extended to a scheme regarding promotion of green biorefining from the January 2018 Targeted Regulation Agreement to support commercial prototype plants.

12. Promotion of green building
Upscaling of the best solutions in green building - including wood construction - must ensure a lower climate impact from the construction. Therefore, there is a need to initiate analysis work and knowledge sharing to ensure that all construction partners can put the latest knowledge, research and innovation into practice. An initiative to promote green building must be initiated, which through a series of analyzes, etc. can gather knowledge and support learning about construction with low climate impact. The work may play a role in any subsequent work on developing a national strategy for green building.

4.3.5 Energy (Fuel Combustion, including Transport, and Fugitive Emissions from Fuels)

Greenhouse gas emissions from energy (as defined by the 2006 IPCC Guidelines for greenhouse gas inventories – i.e. from energy consumption and – in the case of Denmark – from flaring) made up 71% of Denmark's total greenhouse gas emissions in 2017 (without LULUCF), of which CO_2 was the primary emission. 97.7% of the emissions from the energy sector are CO_2. 1.1% is methane (CH_4), and the remaining 1.2% is nitrous oxide (N_2O).

4.3.5.1 ***CO_2***

Energy production and energy-consuming activities in the transport sector and industry are main contributors to the total emissions of CO_2 due to use of large quantities of coal, oil and natural gas. The energy sector is, therefore, centrally placed in efforts to reduce emissions of CO_2.

Many initiatives have been taken over the years to reduce the emissions, and work is still going on to find the best and most cost-effective measures with the objective to fulfil Denmark's international climate obligations.

Danish experience shows that through persistent and active energy policy focus on enhanced energy efficiency and conversion to cleaner and renewable energy sources, it is possible to sustain high economic growth and at the same time reduce fossil fuel dependency and protect the environment.

The energy sector is fully liberalised. Today, electricity production from Danish power plants is controlled by market forces. Danish electricity generation is traded freely across national borders on the Nordic and the north-German electricity markets. Thus there is a significant extent of integration in the Northern European electricity market. This entails, for example, that increased use of renewable energy in the Danish electricity system or enhanced efforts to save electricity do not automatically mean that generation at coal-fired power plants is reduced correspondingly during the first commitment period of the Kyoto Protocol 2008-2012.

The introduction of the CO_2 allowance regulations through the EU emissions trading scheme (EU ETS) has been pivotal for Denmark’s possibilities to comply with the climate commitments. The EU ETS constitutes a central instrument in ensuring that the Danish energy sector is enabled to provide the reductions required if Denmark is to comply with its climate obligations. At the same time, the EU ETS permits significant improvements to the cost effectiveness of Denmark's climate effort.

The government’s long-term objective is to become a nation with an energy supply solely based on renewable energy sources and thus independent of fossil fuels.

The objective of the Danish energy policy today is security of supply, environmental concerns, energy savings and well-functioning energy markets within frameworks that secure cost effectiveness. Several initiatives often meet more than one of the purposes mentioned at the same time. Efforts concerning climate change should thus be seen in a broader context than CO_2 alone, not least when it comes to the purpose and calculation of effects.

Denmark gave priority to renewable energy sources and energy efficiency early on. Most of the public support schemes and regulations have prioritised energy efficiency and renewable energy. In this respect the development in Denmark has been quite different from other IEA countries, which have invested in new energy supply – notably nuclear energy.

Danish public support programmes have instigated competition amongst private companies. Most public support for energy research and development in Denmark has been open for competing applicants. Similarly, all procurement of energy technologies induced by public schemes has followed EU rules requiring open tenders or has left it to competitive markets in general.

A large number of policies and measures have been implemented over the years to meet the various energy-policy objectives cf. Table 4.16.

4.3.5.1.1 The allowance regulation relevant to the energy sector

A key instrument for reaching the goals for emission reductions is the EU Emission Trading Scheme (EU ETS), which is a CO_2 allowance scheme for energy production and energy-intensive industries as described in section 4.3.1. The EU Member States have devised this trading scheme for greenhouse gas emissions in order to fulfil the international climate commitments set out in the Kyoto Protocol, in particular with the aim of reducing CO_2 emissions from energy production and energy-intensive industries.

The allowances scheme entered into force on 1 January 2005. The 2005-2007 period was used as a testing phase. The EU ETS Directive has been revised a number of times.

The allowance allocation for 2008-2012 was determined on the basis of the national allocation plan from July 2006, submitted the European Commission. The EU ETS 2008-2012 has been an important measure in Denmark's fulfilment of its climate obligations under the first commitment period of the Kyoto Protocol. The scheme aligns well with government policy for the energy area on liberalisation of the energy markets and management of environment efforts by the market.

The installations subject to the allowance regulations account for a little less than half of Danish emissions of greenhouse gases. Almost all major Danish installations with considerable emissions are covered by the ETS. Most of these are generators of power and heat, the rest are industrial enterprises plus a few production units within the offshore sector.

Both the statutory and the administrative basis for the scheme have been established. The necessary legal basis was adopted by the Danish Folketing in June 2004 and the 2008-2012 national allocation plan was approved by the European Commission on 31 August 2007.

According to the national allocation plan for the period 2008-2012 an average annual allowance of 24.5 million tonnes CO_2 has been allocated. According to the allocation plan this should correspond to a drop in annual emissions of about 5 million tonnes per year in 2008-2012, or a reduction of about 17% compared with emissions expected in the national allocation plan for the period. This level was set by balancing environmental considerations against competitiveness and jobs:

- Electricity and heat producers were allocated about 15.8 million EAUs. The allowance for electricity generation is allocated as ”per kWh”, while for heat production allowances are allocated according to emissions in the base years 1998-2004.

- The other 133 installations (industry and offshore) have been allocated allowances corresponding to emissions in the base years 1998-2004. A total of 8.2 million tonnes CO_2 per year have been allocated to industry and offshore.

- A special reserve of 0.5 million tonnes CO_2 per year has been allocated with free allowances for new installations and significant extensions to existing units.

Allowances not allocated by the end of the commitment period or returned due to closures have been auctioned. The period 2008 – 2012 was finalized in 2013 with the final surrendering of allowances and credits by companies participating in the EU ETS as shown in section 4.3.1.

The new EU Climate and Energy Agreement from December 2008 extended the ETS system to 2013-2020 in order for the EU to reduce CO_2 emissions by 20% in 2020. At the same time allocation was centralised and auctioning is to be used more extensively from 2013. The allowances have been calculated for this period in accordance with the EU benchmarking decision 2011/278/EU.

The legislative framework of the EU ETS for its next trading period 2021-2030 (phase 4) was revised in early 2018 to enable it to achieve the EU's 2030 emission reduction targets in line with the 2030 climate and energy policy framework and as part of the EU's contribution to the 2015 Paris Agreement. Phase 4 of the EU ETS is still under implementation.

4.3.5.1.2 Energy and CO_2 taxes

Taxes have also been used for many years as an instrument to reduce CO_2 emissions from the energy sector, since fuels used for heat production are subject to energy and CO_2 taxes. The main objective is general GHG reductions and the promotion of the use of fuels with lower CO_2 emissions, mainly biomass. Energy and CO_2 taxes are described in detail in section 4.3.3.

4.3.5.1.3 Combined heat and power

The main elements of the Danish strategy to promote renewable energy and the efficient use of energy resources since the end of the 1970s have been increased use of CHP and expanding of district heating areas. Effective heat supply planning has ensured the highest share of district heating and CHP in the Western Hemisphere. This has secured early markets for district heating technologies and a possibility for the use of many renewable energy sources like straw, municipal waste, wood waste and geothermal energy. About half of Denmark's domestic electricity consumption is produced on CHP plants, and the potential for further use of CHP is limited. Wind energy delivered about 43 % of domestic electricity supply in 2017 and is expected to deliver around 53% of domestic electricity supply by 2020. For this reason the CHP production is expected to be reduced in the future, though CHP and the valuable services CHP plants provide - also in terms of back up capacity - is expected to remain an integral part of the overall system. CHP has been promoted partly by the tax system, partly by electricity production subsidies for biomass and biogas, partly by feed-in tariffs (replaced later by a “base subsidy”).

One of the initiatives in the 2018 Energy Agreement is the modernisation of the heating sector and mitigating the impacts of eliminating the “base subsidy”.

The regulations governing our heat production require modernisation. The energy agreement proposes a change of direction, granting greater flexibility and promoting new green solutions and technologies.

Regulatory constraints on the heat production of district heating plants will be eliminated, giving them the freedom to invest in transitions to greener energy, e.g.

heat pumps, biomass and geothermal systems, thus enabling the transition towards a renewable energy system. The regulatory relief for individual district heating plants will depend on the size of their district heating areas. The last constraints are expected to be lifted by 2030 at the latest.

The 2018 Energy Agreement gives consumers a greater freedom of heating choice. The power to obligate consumers to be connected to the collective heating system will be abolished. This will allow for investment in other individual heating solutions, e.g. heat pumps for single homes.

No new consumer obligations will be permitted as from January 2019, while the consequences of repealing existing consumer obligations will be analysed before the parties to the agreement make a decision on such repeals.

The modernisation will ensure that the district heating sector remains viable without public subsidies once the so-called "base subsidy" is phased out. In the short term, the elimination of this base subsidy may cause higher heating bills for some consumers. Therefore, the energy agreement allocates 540m DKK in the period 2018-2023 for targeted efforts to help heating plants and consumers, and to help manage stranded costs.

The 2018 Energy Agreement will improve the legal and regulatory framework for the heating sector, supporting more voluntary investment in green solutions. This will facilitate the breakthrough of new technologies – heat pumps, geothermal solutions, solar PV, etc – in heating plants and in consumers' homes.

4.3.5.1.4 Renewable energy

The increasing use of renewable energy sources is reducing emissions of CO_2 from fossil fuels. The long term goal for the Danish government is to be a climate neutral society by 2050. The initiatives in the 2012 Energy Agreement cover the energy policy areas for the period until 2020. With the 2018 Energy Agreement additional initiatives for the period after 2020 was adopted.

The expected headline results for 2020 are the following: more than 40% renewable energy in final energy consumption; approximately 50% of electricity consumption to be supplied by wind power; gross energy consumption will continue to drop up to 2020, but then rise slightly towards 2030; and greenhouse gas emissions will be reduced by 37% compared to 1990.

The expansion of energy from offshore wind turbines after 2020 will help ensure that nearly 55% of the nation's energy needs are met with renewable energy by 2030.

Renewable energy sources are promoted with economic measures, including use of energy and CO_2 taxes on fossil fuels and through the Public Service Obligation Schemes (PSO), which have been a supplement to the price of electricity paid by all consumers until 2017. The Danish PSO levy will be phased out during a period of 5 years (2017-2022), and the financing of support to renewables will gradually shift to the State Budget.

As a first step a political agreement was reached in September 2017 on technology neutral tenders in 2018 and 2019 allowing photovoltaic panels and wind turbines to compete to deliver the most green power to consumers. The total budget for the

tenders in 2018 and 2019 is approx. DKK 0.5 billion. In the 2018 a total of 160 MW onshore wind projects and 100 MW solar PV projects won in the tender round with an weighed average price premium of 23 DKK per MWh for a 20 year period.

In addition to the tender scheme, it was also agreed to allocate DKK 150 million for new test wind turbines to be established both inside and outside the two national test centres for large wind turbines in 2018 and 2019.

In accordance with the 2018 Energy Agreement renewable energy on market conditions will be pursued. This includes a continuation of the technology neutral tenders in 2020-2024 with a total budget of DKK 4.2 billion. The costs of establishing offshore wind turbines have decreased significantly in recent years. To support the continuation of this trend, the energy agreement will facilitate the creation of a better framework for realising Denmark's offshore wind potential without state subsidies. However, subsidies may remain necessary for the installation of cables that transport green electricity from offshore wind farms to consumers' outlets.

The 2018 Energy Agreement also establishes a reserve of 400m DKK in 2025 and 500m annually from 2026 to support further efforts to advance the use of RE.

The parties further agreed to allocate funding of 250m DKK annually in 2026-2030 for climate-related efforts. The parties also noted that the gradual expiration of subsidies funded by the PSO tax will free up finances that will be utilised to fund the initiatives in the 2018 Energy Agreement.

Wind power

The 2012 Energy Agreement includes a target of applying another 1900 MW of new capacity from onshore and offshore wind by the end of 2021. Most of the new capacity will come from offshore wind power. In this respect the Danish Energy Agency was responsible for tendering 1350 MW new offshore capacity: The Horns Rev 3 tender of 400 MW in the North Sea, which was inaugurated on 22 August 2019[13], the Kriegers Flak tender of 600 MW in the Baltic Sea with expected commissioning in the period 2019-21 and the so-called near shore tender of 350 MW – Vesterhav Nord and Syd - with expected commissioning in 2023. Also following from the 2012 Energy Agreement the Nissum Bredning test project (28MW) was inaugurated on 12 May 2018[14]. As a result, wind energy is expected to cover 50 % of Danish electricity consumption in 2020.

The 2018 Energy Agreement includes the establishment of three new offshore wind farms 2018-2030 that will supply at least 2,400 MW of green electricity to the energy system[15] – more than the total combined electricity consumption of all Danish households. A variety of factors will be considered before choosing the location of the offshore wind farms, including cost, the surrounding environment, and seabed conditions. A cost-effective expansion of wind energy is essential. Therefore, a sound procurement process will allow for maximum competition to achieve the

[13] https://kefm.dk/aktuelt/nyheder/2019/aug/danmarks-stoerste-havmoellepark-viser-vejen-mod-groen-fremtid/ and https://group.vattenfall.com/press-and-media/news--press-releases/pressreleases/2019/vattenfall-inaugurates-scandinavias-largest-offshore-wind-farm

[14] https://www.tvmidtvest.dk/artikel/her-er-de-vilde-med-vindenergi-moeller-rejst-uden-protester

[15] This was reported as Planned Measure no. E1 in the draft NECP as it was not included in the WEM-projection scenario. The measure is now included in the August 2019 WEM-projection scenario and therefore reported here as adopted.

lowest possible price. In recognition of the significant aesthetic impact that offshore wind turbines can have on the coastal landscape, the energy agreement expands the power of municipalities to reject offshore wind turbines from 8 km to 15 km off the shore.

Biomass

In 2017, biomass accounted for approximately 54% of renewable-energy production, mostly in the form of straw, wood pellets, wood chip and biodegradable waste for incineration. Approximately 82% of the biomass was imported, mainly in the form of wood pellets (54 PJ), biofuels (10.4 PJ), wood chips (5.5 PJ), fire wood (2.6 PJ) and biodegradable waste for incineration (2.2 PJ).

The energy production from biomass has more than doubled since 1990 - primarily due to the policy agreement from 1993 (the Biomass Agreement: requires power plants to use 1.4 million tonnes of straw and wood, equivalent to almost 20 PJ per year) and the policy agreement from February 2008 on the increased use of straw and chips at the large co-generation plants (up to 700,000 tonnes in 2011). At the same time, the consumption of biomass continues to rise as a source of energy for the supply of heat in district-heating plants and in smaller installations for households, enterprises and institutions.

Although it was demonstrated in Denmark in the mid-1990s that biogas plants can be established with reliable operation and with an acceptable economy biogas still only accounted for 6.5% of renewable-energy production in 2017.

Liquid biofuels, such as animal and vegetable oils, biodiesel and bioethanol, is used only on a small scale. Liquid biofuels from bio-waste by the so-called second generation technologies are now at a low level.

4.3.5.1.5 Fuel conversion from coal to natural gas

Substitution of coal and oil by natural gas reduces emissions of CO_2. The first Danish natural gas was landed from the Danish sector of the North Sea in 1984, and since then consumption of natural gas has increased to 193 PJ in 2001. Since then, consumption has decreased to 117 PJ in 2017 due mainly to high gas prices. In 2017, natural gas covered 16% of gross energy consumption. In the power sector, natural gas was introduced in 1985 and peaked with 25% around 2000. In 2017, this had decreased to 7.6%, mainly due to the relation between power prices and gas prices. The use of natural gas is expected to decrease further as a result of introducing more renewable energy and extensive energy-saving policies.

In accordance with the 2018 Energy Agreement, the government will formulate a gas strategy that will provide the necessary basis for a market-based and commercially-utilized gas system. The strategy will, inter alia, explore the potential of biogas and other green gases, thus contributing to a climate-neutral Denmark by 2050 at the latest.

4.3.5.1.6 Research and development

Danish support for new energy technologies has been comprehensive and relatively stable. A long list of direct and indirect support schemes and policies have, in combination, created a domestic market which has given Danish companies a boost.

This boost has enabled many companies to become international market leaders. Danish companies continue to enjoy commercial success within the energy-related marketplace.

R&D activities include energy savings, more efficient energy conversion, renewable energy technologies and efforts within System Integration and Smart Energy.

Research and development activities in the field of energy are not motivated solely by climate issues, but are relevant to climate issues, since they contribute to determining the overall framework for the CO_2 intensity of energy production and consumption in the future.

There is a broad political commitment to support R&D activities through public funding and the Danish Government has in its manifesto by November 2016 stated that Denmark is committed to an ambitious green transition for the national energy supply. This calls for comprehensive R&D efforts for the development of improved and new sustainable energy technologies.

Denmark is one of the partners in the public-private initiative Mission Innovation comprising 22 countries and the European Commission. The aim of Mission Innovation, that was founded in relation to the COP21 in Paris 2015, is to strengthen the multilateral R&D efforts within clean energy technologies to promote a continuous cost effective green transition of the energy systems.

Thus Denmark as one of the partners has chosen to strengthen the dedicated public investments in clean energy research, development and demonstration focusing on reduction of technology costs and CO_2 emissions and with an emphasis on innovative projects that can be replicated and scaled up with the involvement of private investors. Denmark will seek to double these efforts departing from a baseline of the average funding to the Danish Energy Technology Development and Demonstration Programme (EUDP) of the years 2015-2016 and until 2020 where DKK 580 million will be allocated.

The EUDP programme was established in 2008 and since then the programme has supported more than 600 projects with a total of DDK 3 billion. On average, 45-50% of the activities under the Programme are financed by the EUDP and hence the private investments in the supported projects are of the same size as the public support leading to approximately to DKK 6 billion in total investments. The Danish Parliament has dedicated DKK 400 million for EUDP for the fiscal year 2018.

A minor programme is administrated on behalf of the power distribution companies by the Danish power association Dansk Energi. The objective is to support research and development within energy-efficient use of electricity through development of energy-efficient products and processes in buildings, industry etc. The annual funds for this programme are DKK 25 million.

Activities relating to strategic research and innovation in general are since 2014 administrated by Danish Innovation Fond. The Fund covers all sorts of research and innovation projects and is not limited to energy matters. However, for 2017 and 2018 DKK at least 100 million /year will be earmarked for R&D within new and clean energy technologies.

In 2018, the energy and climate research was strengthened with the 2018 Energy Agreement.

The parties to the 2018 Energy Agreement intend to phase in additional state funding for energy and climate research, going from 580m DKK in 2020 to a target of 1 billion DKK annually from 2024. These funds will be earmarked for research, development and demonstration of new technology.

Intensifying energy and climate research as we move towards 2030 will ensure continued efforts to develop the technologies that will help Denmark's energy system transition to cleaner and greener solutions. Research and development in new energy and climate technology solutions will also generate new opportunities for growth, jobs and Danish technology exports.

The research funding will support Denmark's commitment to the international collaboration Mission Innovation, in which a number of countries have pledged to increase energy research funding by 2020. With an ambitious funding target of 1 billion DKK from 2024 onwards, Denmark further cements its long-term commitment to research, development and demonstration in the field of energy and climate. Through Danish initiatives such as the Energy Technology Development and Demonstration Program (EUDP) and Innovation Fund Denmark, Denmark is contributing to the global cooperation to develop the energy and climate technologies of tomorrow.

The EUDP funding will support the development and demonstration of Danish energy technology solutions, with a view to subsequent commercialisation. These solutions may range from new floating foundations for offshore wind turbines, to large scale demonstration projects such as Nordhavns Lab, which intelligently integrates various energy technology solutions.

Strategic and applied energy research is among the many activities supported by Innovation Fund Denmark. This funding is awarded directly to talented researchers, entrepreneurs and companies, as well as to others with strong ideas about energy technology solutions for the benefit of society.

4.3.5.1.7 Energy savings

Reducing energy consumption by increasing energy efficiency and promoting energy saving is a very important element for Danish energy policy.

Among the grid and distribution companies (electricity, natural gas, oil and heating), the electricity companies have been working with energy savings since the early 1990s and the natural gas and district heating companies have been working with energy savings since 2000.

Since 2006, several political agreements have been reached to significantly strengthen the energy savings efforts in Denmark.

The obligations have been implemented as voluntary agreements between the Minister of Energy, Utilities and Climate and grid and distribution companies. Energy companies' costs are financed by a levy on their tariffs.

In the policy agreement from 2012, the obligation for the grid and distribution companies in the electricity, natural gas, district heating and oil sectors was increased by 75% in 2013 and 2014 (to 10.7 PJ) and by 100% in 2015 (to 12.2 PJ). In December 2016, the Minister of Energy, Utilities and Climate entered a new agreement on energy savings with the grid and distribution companies for the period 2016-2020. The obligation was decreased from 12.2 PJ to 10.1 PJ in 2016 to 2020.

The agreement ensures Denmark's continued implementation of Article 7 of the EU Energy Efficiency Directive.

Targeted work to improve energy efficiency specifically in the public sector has been going on for many years, and considerable savings have been achieved. In 2014 a new circular on energy efficiency in state institutions was reviewed in line with the requirements in Articles 5 and 6 of the EU Energy Efficiency Directive.

The ministries obligated under the existing Ministerial Order are bound by an energy savings target, but are at liberty to pursue the instruments which are most cost effective in their particular circumstances, including deep renovations; behavioural measures etc.

Data on energy consumption in the public sector have been collected for some years as means of rendering the sector's energy consumption visible.

TABLE 4.16 MEASURES IN THE ENERGY SECTOR (SEE ALSO SPECIFIC MEASURES IN TABLE 4.17 (BUSINESS), 4.18 (HOUSEHOLD S) AND 4.19 (TRANSPORT)).

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
EN-1: EU-CO2-emission trading scheme for electricity and district heat production and certain industrial processes (incl. Business) and aviation from 2012	Yes*	Energy, Industry/Industrial processes, Cross-cutting	CO2	Switch to less carbon-intensive fuels (Energy supply), Increase in renewable energy (Energy supply), Efficiency improvement in the energy and transformation sector (Energy supply), Control of fugitive emissions from energy production (Energy supply)	Regulatory, Economic	Implemented	See text.	2005	Government: Danish Energy Agency and entities uner the EU ETS	IE (G1, G3 and G4)	IE (G1, G3 and G4)	
EN-2: Biomass Agreement (Agreement on the use of biomass in electricity production)	Yes*	Energy	CO2	Increase in renewable energy (Energy supply)	Economic, Voluntary Agreement	Implemented	See text.	1993	Government: The electricity producers	1100 and IE (G1 and G3)	1100 and IE (G1 and G3)	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).
EN-3: Price supplement and subsidies for renewable energy production	Yes*	Energy	CO2	Increase in renewable energy (Energy supply)	Economic	Implemented	See text.	2008	Government: Danish Energy Agency and entities responsible for energy production	IE (G1 and G3)	IE (G1 and G3)	
EN-4: Tenders for offshore wind turbines	Yes*	Energy	CO2	Increase in renewable energy (Energy supply)	Regulatory	Implemented	See text.	2013	Government: Danish Energy Agency and entities responsible for energy production	IE (G1 and G3)	IE (G1 and G3)	
EN-5(expired): Scrapping scheme for old wind turbines	Yes*	Energy	CO2	Increase in renewable energy (Energy supply)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2008	Government: Danish Energy Agency	IE (G1 and G3)	IE (G1 and G3)	
EN-6: Energy development and demonstration	Yes*	Energy	CO2, CH4, N2O	Research and development (), Research and development (), Research and development ()	Information	Implemented	See text.	2008	Government: EUDP Secretariat c/o Danish Energy Agency	IE (G1)	IE (G1)	
G3: All RE mitigation actions (Renewable Energy) since 1990	Yes*	Combined (EN-2, EN-3, EN-4, EN-5, BU-8 and TR-8)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	**29702**	**58325**	Estimated in September 2019 based on the energy projection from August 2019. The methodology is described in Denmark's 7th National Commination, Annex B4.
G4: All EE mitigation actions (Energy Efficiency) since 1990	Yes*	Combined (TD-b1, -2, -3, -4, -5, -6, -7; EN-1; BU-1, -2, -6, -7, -9, -10; TR-1a, -1b, -2, -3, -4, -5, -6, -7, -10, -11, -12; HO-1, -2, -3, -4, -5, -6)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	**17583**	**13231**	Estimated in September 2019 based on the energy projection from August 2019. The methodology is described in Denmark's 7th National Commination, Annex B4.

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.5.1.8 Specific measures in the business sector (Fuel combustion in Manufacturing Industries and Construction, Commercial/Institutional and Agriculture, Forestry and Fisheries)

Energy use in the business sector covers energy use in Manufacturing Industries and Construction, Commercial/Institutional and Agriculture, Forestry and Fisheries (cf. the 2006 IPCC Guidelines for greenhouse gas inventories). In 2017, energy use in the business sector was responsible for 13.2% of Denmark's total greenhouse gas emissions.

In 2017, the greenhouse gas emissions from energy use in the business sector decreased by approximately 34% from 9.6 million tonnes CO_2 equivalents in 1990 to 6.3 million tonnes CO_2 equivalents in 2017, primarily due to improvements in energy efficiency and energy savings.

According to the August 2019 projection, the expected emissions from the business sector's energy use are an average of 6.3 million tonnes CO_2 equivalents in 2017 decreasing to 5.6 million tonnes CO_2 equivalents in 2030.

The on-going initiatives to reduce emissions from the business sector include promotion of energy savings and energy-efficiency improvements as well as conversion of energy production to cleaner fuels. Certain energy-intensive businesses are also subject to allowances regulation as a consequence of the EU Emission Trading Scheme.

Analyses have shown that there is a big potential for profitable energy-efficiency improvements within the business sector, so improving energy efficiency is a vital area of action.

The measures implemented in the business sector are shown in Table 4.17[17].

Industry is responsible for most of the sectors' emissions of CO_2. The emissions come mainly from energy-consuming activities in industry. Cement and brick production also contributes especially high levels of CO_2, due to the raw materials used.

The main instrument to reduce CO_2 emissions in energy-intensive industry is the EU's emission allowance scheme, covering about 120 industry installations.

Business and industry have introduced major energy efficiencies over the past 25 years. This is mainly due to a green tax package for the business sector, which was firstly introduced in 1995. The package contained a combination of taxes and discounts for energy intensive enterprises. The package led to a higher CO_2 tax and the introduction of a space-heating tax for businesses. In order to get the tax discount, the eligible energy intensive enterprises have to sign an agreement on energy efficiency with the Danish Energy Agency. With the political agreement on economic growth from 2013, the CO_2 tax on electricity in production process in the industry was abolished and the voluntary agreement scheme ended. Electricity production is thus included in the ETS. With a political agreement on economy growth from July 2014 it was decided to revive the voluntary agreement scheme. The new scheme entered into force in September 2015. The current scheme subsidizes

electricity-intensive enterprises payment of electricity tax (the PSO tax until 2020 – cf. the phase-out of the PSO mentioned in Chapter 4.3.4.1.4).

Today business not included in the ETS are imposed the CO_2-tax on their fossil fuels for process and all business are imposed the CO_2-tax on their fossil fuels for space heating regardless of the business is included in the ETS. Business pay an energy tax of DKK 4,5 per GJ on their fossil fuels used for process and an energy tax of DKK 55,5 per GJ on their fossil fuels for space heating (2018 tax rates). Some business, e.g. mineralogical and metallurgical processes, are exempt of the energy tax on their process and agriculture pay a lower rate than DKK 4,5 per GJ. VAT registered business pay in general a tax on electricity of DKK 0.004 per kWh except on their electricity for space heating where they pay a higher rate.

As an element in the implementation of the 2012 energy policy agreement, a DKK 3.75 billion (€500m) fund was established to subsidise industries to convert to renewable energy. As of August 2013, businesses have been able to get investment subsidy from this fund to convert from fossil fuel (i.e. coal, oil, gas) to renewable energy sources (i.e. biomass, solar, wind) or district heating in their production process. The subsidy also includes investments in energy-efficiency measures. The estimated effect of this "Renewables for industry" initiative is a reduction of 1 million tonnes of CO_2 per year from 2020 and onwards. As a result of a political agreement of November 2016, the scheme expired at the end of the 2016.

Large enterprises in Denmark are by law required to have a mandatory energy audit every fourth year. The law is no. 345 of 8th of april 2014 "Lov om ændring af lov om fremme af besparelser i energiforbruget, lov om varmeforsyning, lov om kommunal fjernkølig og forskellige andre love". The law transposes the energy efficiency directive article 8. Denmark has defined large enterprise in accordance with the EU definitions saying that enterprises that do not fall under the category of micro, small and medium-sized enterprises, in accordance with the Commission's recommendation 2003/361/EC of 6 May 2003 concerning the definition of micro, small and medium-sized. Enterprises with ISO 50,001 or ISO 14,001 are exempt. The deadline for the first energy audits was the 5th of December 2015 and afterwards every fourth year. The scope of the energy audit is buildings, processes and transport. There is no requirement of implementing the energy saving proposals from the energy audits.

As part of a political agreement on economic growth from June 2014 a DKK 40 million (5.4 mio. EURO) fund was established to run a centre for energy savings in enterprises. The money was given for the period 2014-2017. The aim of the centre is to identify and exploit the energy efficiency potential already existing within primarily small and medium sized companies. The large companies are covered by the voulantary agrement scheme and the mandatory energy audit.

With a view to promote targeted energy savings, the 2018 Energy Agreement allows the current energy efficiency obligation scheme to expire by the end of 2020, and replaces it with a new subsidy scheme for energy efficiency improvements in businesses.

The 2018 Energy Agreement introduces a new scheme with subsidies for energy efficiency improvements in businesses from 2021-2024. These funds will be limited to 300m DKK and there will be an individual subsidy cap. The scheme for

businesses targets energy consumed in the delivery of services and manufacture of products – also known as “process energy”.

Denmark’s municipalities and regions own a total building mass of more than 36 million square metres. The energy efficient operation and renovation of these buildings holds great potential for reducing energy consumption. Therefore, the energy agreement allocates 100m DKK annually in the period 2021-2024 for loans to finance energy renovations in buildings owned or operated by municipalities and regions.

The energy agreement allocates 19m DKK in 2018, 33m DKK in 2019, 34m DKK in 2020, and 44m DKK annually from 2021-2024 for information activities relating to energy savings. This funding is also earmarked for the utilisation of data to promote energy efficiency.

TABLE 4.17 MEASURES IN THE BUSINESS SECTOR

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
BU-1: Agreements on energy efficiency with business	Yes*	Energy	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Voluntary Agreement, Economic	Implemented	See text.	1993	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
BU-2: Savings activities by elec. grid, gas, oil and district heating companies (consump. of final energy excl. Transp.)	Yes*	Energy	CO2	Demand management/reduction (Energy consumption)	Information	Implemented	See text.	2006	Government: Danish Energy Agency	60 and IE (G1 and G4)	60 and IE (G1 and G4)	Estimates in 2017 - based on The 2013 Analysis of the Effects of Selected Measures for the National Audit Office, Danish Energy Agency, December 2013 (http://www.ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/kyoto-samlenotat_9._december.pdf (an English translation is included in Annex B3))
BU-6: Circular on energy-efficiency in state institutions	Yes*	Energy	CO2	Efficiency improvement in services/ tertiary sector (Energy consumption)	Regulatory	Implemented	See text.	2005	Government: The Danish Energy Agency is responsible for the circular. The individual ministries and state institutions are responsible for the implementation of the circular.	IE (G1 and G4)	IE (G1 and G4)	
BU-7(expired): Campaigns and promotion of efficient appliances (including elec. heating, conversion and efficient appliances in households)	Yes*	Energy	CO2	Efficiency improvement of appliances (Energy consumption)	Information	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	1997	Government: The Minister for Climate and Energy / The Danish Energy Authority	IE (G1 and G4)	IE (G1 and G4)	
BU-8(expired): Renewables for the industry	Yes*	Energy	CO2	Increase in renewable energy (Energy supply)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2013	Government: Danish Energy Agency, other state authorities, enterprises	1000	IE (G1)	The estimate for 2020 shown here is a former separate estimate for this measure. Although this measure has expired it is still included in the list as some effect of the implementation carried out before expiration remain. But this has not been quantified separately. The separate estimate shown here is not included in the calculation of the total effect of all measures.
BU-9: Mandatory Energy Audit for large Enterprises	Yes*	Energy	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Regulatory	Implemented	See text.	2014	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
BU-10: The center for energy savings in enterprises	Yes*	Energy	CO2	Efficiency improvement in industrial end-use sectors (Energy consumption)	Information	Implemented	See text.	2014	Government: Danish Eneergy Agency	IE (G1 and G4)	IE (G1 and G4)	
G4: All EE mitigation actions (Energy Efficiency) since 1990	Yes*	Combined (TD-b1, -2, -3, -4, -5, -6, -7; EN-1; BU-1, -2, -6, -7, -9, -10; TR-1a, -1b, -2, -3, -4, -5, -6, -7, -10, -11, -12; HO-1, -2, -3, -4, -5, -6)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	**17583**	**13231**	Estimated in September 2019 based on the energy projection from August 2019. The methodology is described in Denmark's 7th National Comminication, Annex B4.

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.5.1.9 Specific measures in the Transport sector

In 2017, the transport sector was responsible for 27.6% of Denmark's total greenhouse gas emissions. The emissions from the transport sector are primarily CO_2 with a share of 98.9% of the transport sector's total greenhouse gas emissions. Nitrous oxide makes up approximately 1.1% and methane about 0.1%.

In 2017, the transport sector's final energy consumption - primarily oil products - made up 27.6% of total final energy consumption in Denmark (without military and fuel sold for international aviation). The consumption of energy for transport has increased by 21.5 % since 1990. The most recent baseline scenario from August 2019 predicts an increase in the sector's greenhouse gas emissions peaking with a 24.7 % increase from 1990 to 2023 followed by a 6% point decrease until 2030.

Table 4.18 shows the existing policies and measures within the transport sector. A number of important steps have been taken by the European Union. Most important of all is probably the EU's requirements on average CO_2 emissions for passenger cars and vans, i.e. the mechanism imposing fines on manufacturers if they fail to comply with the CO_2 targets.

CO_2 measures at EU level and Danish measures aimed at reducing the transport sector's CO_2 emissions are described under the measures sections below.

The national environmentally motivated measures for the transport sector, which have also influenced CO_2 emissions, are usually characterised by aiming at limiting environmental impacts in general. The registration tax and the annual tax (the green owner tax) which is dependent on the energy efficiency of the vehicle as well as fuel taxes are assessed to have had considerable effects on CO_2 emissions.

Transport in itself has a number of side-effects in addition to contributing to the greenhouse effect through higher CO_2 emissions, for example air pollution causing poor air quality or acidification, noise, accidents and congestion. It is thus important to note that the various initiatives implemented in the transport area typically address many of these aspects as well - and thus cannot only be considered in relation to CO_2 emissions.

From 2012 all petrol and diesel for transport sold in Denmark must contain an average of 5.75% of biofuels, which must live up to the EU sustainability criteria. According to the Energy Agreement of March 2012 a 10 percent target is foreseen by 2020. However this will depend on the political agreement expected to be reached in 2018-2019.

Cars with high energy efficiencies, such as electric vehicles, are granted large reductions in the registration tax. Electric vehicles and plug-in hybrid vehicles are furthermore granted deductions in the registration tax until 2021. Hydrogen vehicles are exempted from the registration tax until the end of 2020.

Additional taxinitiatives regarding low and zero emission vehicles is planned with the 2018 Climate and Air proposal. These initiatives are described in chapter 4.3.5.1.12.

When it comes to transport infrastructure, a historically high level of national-level investments have been approved since 2009, and the clear majority of these investments have gone to rail projects (as opposed to road projects). Many of these projects are currently under construction. Including only major projects – and only projects carried out solely or partly by the national level – the value of the current rail projects under construction is around 129 billion DKK (compared to around 38 billion DKK for current road projects). In 2013, the former government decided to allocate the future proceeds from a change in the oil industry taxation to a fund for the improvement of the rail infrastructure in Denmark. The upgrade is expected to reduce travel times and CO_2 emissions substantially. Given the current, lower oil-prices and therefore the reduction in income from taxation, the former government carried out a review of the planned investments. This has resulted in a lower level of investment from the fund (included in the above mentioned investment totals) where the electrification of the main lines and the regional lines on Zealand and certain speed upgrade has been given priority so far. Certain further investments from this fund can be expected in the coming years, but further rail investments must take into account the current amount of large and interfering projects, which limits the feasibility of further rail investments in the shorter term.

The tunnel under the Fehmarn Belt including adjacent landworks will reduce CO_2 emissions by potentially 200,000 tonnes per year. This is mainly due to the following effects:

1. Rail freight trains will reduce the travel distance by 160 km

2. Rail transport for passengers and freight will be strengthened

3. The current ferry service between Rødby and Puttgarden is expected to cease operation.

The 2018 Energy Agreement allocates an additional 500m DKK for green transport solutions over the period 2020-2024.

In accordance with the former government's 2018 Climate and Air proposal a commission for the transition to green cars has been established with a view to analyze measures for the promotion of green cars on a large scale in Denmark. The commission will also look into how to remove barriers, expand and restructure the infrastructure for the new car types and economically prepare society for a large scale expansion of green cars. The green conversion of the transport sector, with the current tax system, will mean lost revenues for the state. In the state budget today there is a solid source of income from registration taxes, annual owner taxes, fuel and other car related taxes of approx. DKK 50 billion annually, which amounts to approx. 5 pct. of the state's total revenue. Regardless of whether we push technology development or not, the proceeds from current fuel taxes will decrease as the cars become more and more energy efficient. The commission will therefore also be tasked with making proposals that can provide alternative revenues.

Furthermore there will be no registration tax in 2019 and 2020 on green cars priced below 400,000 DKK. Further information on this is included in Chapter 4.3.3.1.2.

In accordance with the former government's 2018 Climate and Air proposal municipalities now have greater powers to grant parking discounts for low-emission

cars and allow low- and zero-emission cars to run in bus lanes. Cheaper parking in towns and allowances for driving in bus lanes can make low and zero emission cars – and thereby the choice of green transportation in the city – more attractive.

Also following from the former government's 2018 Climate and Air proposal it is now easier for passengers to choose a green taxi rather than a conventional taxi at stations and other similar traffic hubs by reserving space for the green taxis at the front of the queue. The green change of the taxi business is supported through the initiative to establish more and faster chargers, where special attention is paid to the taxi business's needs when placing the chargers. Furthermore, up to 300 out of 750 taxi drivers with zero emission vehicles applying for new taxi licenses in 2019 and 2020 are now guaranteed a taxi license.

The oldest diesel cars contribute disproportionately to air pollution in the cities and at the same time have a higher CO_2 emission than newer diesel cars. Funds for a temporarily raise of the scrap premium for older diesel cars in 2019, in total DKK 100 million, has been allocated and spent in the period from 1 February to 1 July 2019. With this initiative owners of old diesel cars from before 2006 could receive a scrap premium of DKK 5,000.

TABLE 4.18 MEASURES IN THE TRANSPORT SECTOR

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
TR-1a: EU demands on vehicle manufactures to deliver fuel efficient cars and vans	Yes*	Transport	CO2	Efficiency improvements of vehicles (Transport)	Regulatory	Implemented	See text.	2000	Other: European Commission	600 and IE (G1, G4 and G5)	600 and IE (G1, G4 and G5)	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).
TR-1b(expired): Information campaign on fuel consumption of new cars	Yes*	Transport	CO2	Demand management/reduction (Transport), Improved behaviour (Transport)	Information	Implemented (and Expired - but included as it is expected to have influenced the level of	See text.	2000	Government: Denmark`s Road Safety and Transport Agency	IE (G1, G4 and G5)	IE (G1, G4 and G5)	
TR-2(expired): Energy-correct driving technique	Yes*	Transport	CO2	Improved behaviour (Transport)	Information	Implemented (and Expired - but included as it is expected to have	See text.	2000	Government: Ministry of Justice	IE (G1, G4 and G5)	IE (G1, G4 and G5)	
TR-3(expired): Initiative on enforcing speed limits	Yes*	Transport	CO2	Improved behaviour (Transport)	Information, Economic	Implemented (and Expired - but included as it is expected to have	See text.	2014	Government: Ministry of Justice	IE (G1, G4 and G5)	IE (G1, G4 and G5)	
TR-4(expired): Establishment of intermodal installations	Yes*	Transport	CO2	Modal shift to public transport or non-motorized transport (Transport), Improved behaviour (Transport)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2014	Government: Ministry of Transport and Energy, municipalities, Danish State Railways (DSB)	IE (G1 and G4)	IE (G1 and G4)	
TR-5(expired): Promotion of environmentally friendly goods transport	Yes*	Transport	CO2	Modal shift to public transport or non-motorized transport (Transport), Demand management/reduction (Transport), Improved behaviour (Transport)	Economic, Information	Implemented (and Expired - but included as it is expected to have	See text.	2014	Government: Danish Environmental Protection Agency, Haulage contractors	IE (G1 and G4)	IE (G1 and G4)	
TR-6(expired): Reduced travel times for public transport	Yes*	Transport	CO2	Modal shift to public transport or non-motorized transport (Transport), Demand management/reduction (Transport)	Regulatory	Implemented (and Expired - but included as it is expected to have influenced the level of	See text.	2014	Government: Ministry of Transport and Energy and Danish State Railways (DSB)	IE (G1 and G4)	IE (G1 and G4)	
TR-7: Spatial planning	Yes*	Transport	CO2	Low carbon fuels/electric cars (Transport), Demand management/reduction (Transport), Improved transport infrastructure (Transport)	Regulatory	Implemented	See text.	2000	Local: Municipalities	IE (G1 and G4)	IE (G1 and G4)	
TR-8: EU requirements regarding biofuels	Yes*	Transport	CO2	Low carbon fuels/electric cars (Transport)	Regulatory	Implemented	See text.	2012	Government: Danish Energy Agency	290 and IE (G1 and G3)	290 and IE (G1 and G3)	Estimates in 2017 - based on The 2013 Analysis of the Effects of Selected Measures for the National Audit Office, Danish Energy Agency, December 2013 (http://www.ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/kyoto-samlenotat_9._december.pdf (an English translation is included in Annex B3))
TR-9(expired): Transport infrastructure projects in the fields of electric vehicles, gas and hydrogen	Yes*	Transport	CO2	Low carbon fuels/electric cars (Transport), Improved transport infrastructure (Transport)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of	See text.	2014	Government: Ministry of Transport	IE (G1)	IE (G1)	
TR-10: Electrification of parts of the rail infrastructure	Yes*	Transport	CO2	Improved transport infrastructure (Transport)	Economic	Adopted	See text.	2014	Government: Ministry of Transport	IE (G1)	IE (G1)	
TR-11(expired): Investments in a new metro line and bicycle transport facilities.	Yes*	Transport	CO2	Improved transport infrastructure (Transport)	Economic	Implemented (and Expired - but included as it is expected to have	See text.	2014	Government: Ministry of Transport, Local:Municipality of Copenhagen	IE (G1)	IE (G1)	
TR-12: Investment in a tunnel under the Femern Belt	Yes*	Transport	CO2	Improved transport infrastructure (Transport)	Economic	Adopted	See text.	2028	Government: Ministry of Transport	-300	200	Estimates for the construction phase (emissions of 300 kt CO2eq/year) and operation phase (reduktion of 198.5 kt CO2eq/year) in the 2013 EIA for the project, Chapter 19 (https://www.trm.dk/da/publikationer/2013/vvm-for-femern-baelt).
G5(new): Energy effciency in transport by passenger cars	Yes*	Combined (TD-6, TR-1a, TR-1b, TR2 and TR-3)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	550	550	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.5.1.10 Specific measures in the residential sector

In 2017, the residential/household sector contributed to Denmark's total national greenhouse gas emissions with 2.1 million tonnes of CO_2 equivalents, corresponding to a share of 4.3%. The residential sector in the greenhouse gas inventory only includes CO_2 emissions from burning of oil and natural gas since emissions from production of electricity and district heating used by households are attributed to the plants where the electricity and heat is produced.

Approximately 92% of greenhouse gas emissions from the residential sector in 2017 consisted of CO_2. There are also small emissions of methane and even smaller emissions of nitrous oxide.

In this section measures addressing all types of energy consumption in the household sector are described, although some of the energy savings will result in emission reductions in the energy production sector.

In 2017, consumption of energy by households, including electricity and district heating, was responsible for around 30% of the total final energy consumption in Denmark.

The major part of energy consumption in households is used for space heating - 83% in 2017. District heating constituted 44% of household energy consumption for heating in 2017. When district heating is produced at CHP plants or with renewable energy, there are big CO_2 savings overall from the use of district heating instead of individual heating based on, for example, oil-fired boilers.

Oil consumption for heating fell from 22% of household energy consumption in 2000 to 6% in 2017. In 2030, oil is expected to amount to less than 2% of final energy consumption for heating, assuming that recent decades' phase-out of oil consumption for heating continues.

Up to 2003, households changed to gas in particular, but from 2004 onwards the change is more to wood pellets in particular. Up to 2030, wood pellet consumption is expected to fall by 3.5% annually, whereas consumption of oil and gas is expected to fall. The falling consumption of wood pellets and fossil fuels will be offset by an increasing contribution from heat pumps.

Despite a rising number of electrical appliances, the associated electricity consumption has remained constant over the past 15 years. This is because electrical appliances have become more efficient, partly as a consequence of the EU Ecodesign Directive and the Energy Labelling Directive.

The reduction of taxes in accordance with the Energy Agreement from June 2018 is expected to trigger a rise in electricity consumption. Meanwhile, other energy agreement initiatives will ensure that renewable energy output in Denmark matches the country's total electricity consumption by 2030.

Households' disposal of waste also contributes to emissions of methane from landfill sites.

The action being taken on households' waste and transport consumption is described in the sections on waste and transport. This section therefore concentrates on the possibilities of reducing the CO_2 emissions through savings in electricity and heating in households and the possibilities for conversion to more environment-friendly forms of heating. The possibilities for reduction in the public energy supply system are described in the section on the energy sector.

In 2017, the final energy consumption in the household sector was 162.5 PJ for space heating and hot water (climate-corrected) and 31.4 PJ of electricity for appliances, etc. Consumption for heating has been quite constant for a number of years, in spite of an increase in the number of households and in the area heated. The consumption of electricity for appliances, etc. is still increasing. The increase in the consumption of electricity has, however, not been nearly as great as the increase in the number of appliances, since these have become steadily more energy efficient.

With a view to reducing energy consumption and environmental impacts from the household sector, a wide range of initiatives have been launched, as described in Table 4.19 in order to promote:

- Electricity savings,
- Savings in energy consumption in space heating, and
- Fuel conversion (from the use of oil to district heating and the use of renewable energy).

Several concrete measures and incentives already implemented are described below.

Energy taxes

All energy consumption for space heating as well as other energy consumption in households and the public sector, as well as non-VAT-registered businesses is subject to energy taxes. Throughout the 1990s CO_2 and energy taxes have steadily increased, but since 2002 they have been almost stable. The CO_2 tax was increased in 2010 by more than 50 pct. The increases have mainly affected households, helping to reduce their energy consumption.

As expanding infrastructure powered by renewable energy will be a key component in Denmark’s successful green transition, the 2018 Energy Agreement included initiatives with a view to reducing taxes on electricity and restructure the rules on surplus heat utilisation. Increased electrification is essential to harnessing the full potential of green energy, and will enable the integration of fluctuating outputs of wind and solar energy into our energy system. Green electricity can be converted into heat and channelled through district heating systems or into large-scale heat storage facilities – ensuring a flexible energy system and optimum utilisation of green electricity.

Electrification of the energy system is thereby a cornerstone of the green transition.

Despite a steadily growing supply of green electricity, the taxes on electricity for households in Denmark remain very high. High taxes on electricity constrain the use of electricity by Danes, causing significant socioeconomic losses. To address this problem, the energy agreement calls for reductions in the electrical heating tax and electricity tax. The reduction of taxes is expected to trigger a rise in electricity

consumption. Meanwhile, other energy agreement initiatives will ensure that renewable energy output in Denmark matches the country's total electricity consumption by 2030. Electrical heat pumps are furthermore expected to replace heating based on fossil fuels and biomass.

Agreed tax reductions:

- The electrical heating tax will be reduced from 0.307 DKK/kWh to 0.155 DKK/kWh, effective 2021.

- The electricity tax will be reduced from 0.914 DKK/kWh to 0.774 DKK/kWh (phased in from 2019-2025).

- The electricity tax for certain liberal professions will be reduced from 0.914 DKK/kWh to 0.004 DKK/kWh in 2023.

Beginning in 2020, 100 million DKK will be earmarked annually for revising regulations that govern surplus heat and promoting its utilisation. A working group will be tasked with exploring electricity tariffs and related issues, including the conditions for certain groups of electricity customers and whether tariffs can be billed in a different and better way. The possibility of a dynamic electricity tax will also be explored. The tax reductions will equate to lower electricity bills, thus improving the productivity of businesses and the welfare of individual households.

CO_2 taxes

Some of the energy consumption in households is subject to CO_2 taxes. The CO_2 tax is further described in section 4.3.3.

Minimum energy requirements for buildings

Denmark has a long experience with energy efficiency and energy savings in buildings. From 1990 to 2017 energy consumption for heating has been reduced by 16.1% per m^2. The goal is to reduce energy consumption in new buildings by 75% by 2020 relative to 2006.

All new buildings must, according to the Danish building code, be constructed as nearly zero-energy buildings (NZEB).

The benefits of reducing energy consumption are tangible: less fossil fuel is consumed and the environment has improved substantially. Strict and progressively tightened building regulations since 1977 have ensured a stable demand for energy-efficient building technologies.

Energy labelling of buildings when built, sold or rented

Energy labelling of buildings must be implemented after finishing the construction of a building and on the sale or rental of the building - primarily heating consumption. This applies in principle for all buildings, irrespective of size, apart from production facilities, factories etc. The energy performance is expressed by a numeric indicator of primary energy in kWh/m2 per year based on the primary energy factor.

Regular energy labelling of large buildings and public buildings

The Energy Performing Certificate (EPC) consist of an energy label and an energy plan. For publicly owned buildings over 250 m^2 the EPC must be prepared regularly every ten years. Furthermore all large buildings over 600 m^2 which are frequently visited by the public must display the EPC in a prominent place clearly visible to the public.

Minimum energy requirements and energy labelling of appliances

The Danish Energy Agency has a national energy labelling scheme for façade windows. Approximately 90 % of suppliers adhere to the scheme. Danish authorities play an active role both in negotiation of compulsory EC requirements and in securing awareness of and compliance with these, including through information on the Agency's website. But in general, the effect of EC product regulation is accounted for elsewhere.

Subsidy scheme related to buildings

The subsidy scheme related to buildings allocates DKK 200 million for each year in the period 2021-2024. The scheme will be implemented as a competitive subsidy scheme aimed at achieving energy savings in buildings. Financial aid will be given to owners of buildings who have renovated their buildings in accordance with a specific list of energy savings belonging to the subsidy scheme.

Information initiative towards private households

The 2018 energy agreement allocates funding for information activities relating to energy savings. The main target is to promote energy-efficient solutions and energy renovation of buildings. The measures of the initiative will be information campaigns, web-based information for private households etc., primarily via social media and the website SparEnergi.dk. The initiative also includes utilisation of data to promote energy efficiency.

Knowledge Centre for Energy Savings in Buildings

The Knowledge Centre for Energy Savings in Buildings is a service for craftsmen and educational institutions concerning energy efficiency improvements. The centre has worked with industry organisation within the area of mediating knowledge to its members, and provides courses to support the general further education of craftsmen. Furthermore, educational efforts are carried out by the labour market training centres.

Heat pumps as an energy service

In this initiative, which has been deployed since 2016, energy companies install, finance, run and maintain heat pumps installed in smaller residential and commercial buildings. Customers have no up-front investment cost but pay for the supplied heat much as they would for district heating. This has increased the number of heat pump installations, and heat pumps in the scheme tend to operate more efficiently, because they are run by professionals rather than building owners.

The initiative is targeting mainly areas without supply of natural gas or district heating.

The 2018 Energy Agreement focuses on the remaining oil-fired boilers and barriers to promote the use of heat pumps. There are currently app. 80000 oil-fired boilers

heating Danish homes. To reduce this number, annual funding of 20m DKK from 2021-2024 will be allocated for a support scheme to promote the replacement of oil-fired boilers with heat pumps.

Furthermore it was decided that no new consumer obligations will be permitted as from January 2019, while the consequences of repealing existing consumer obligations will be analysed before the parties to the agreement make a decision on such repeals.

"Better Houses"

"BetterHouses" is a scheme (voluntary and market-driven system) from the Danish Energy Agency focusing on energy renovation of buildings. The aim is to make it easier for owners of buildings, mostly homeowners, to energy renovate by creating a "one stop shop" for energy renovation, where the owner only has to contact one certified building contractor and to get an overall counselling on energy renovation of the entire building. Skilled workmen are educated under the BetterHouses program to be advisors on energy renovation. The Danish Energy agency approves the BetterHouses firms and professionals like architects, engineers, craftsmen, energy consultants and building designers can take training courses to become BetterHouses advisors. The training is carried out at academies of higher education. A Better Houses advisor can manage the process and can follow the project all the way from plan to completed renovation.

Strategy for energy renovation of buildings

In May 2014 a strategy for energy renovation of buildings was adopted. The strategy contains initiatives which will promote the renovation of the Danish building stocks and insures that energy efficiency measures are implemented on the buildings.

In accordance with the revised energy performance of buildings directive, Denmark will establish a long-term renovation strategy in 2020 to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

TABLE 4.19 MEASURES IN THE HOUSEHOLD (RESIDENTIAL) SECTOR

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
HO-1: Energy labelling of small and large buildings (incl. public sector and business)	Yes*	Energy	CO2, CH4, N2O	Efficiency improvements of buildings (Energy consumption)	Regulatory, Information	Implemented	See text.	1997	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
HO-2: Energy labelling of electric appliances	Yes*	Energy	CO2	Efficiency improvement of appliances (Energy consumption)	Information	Implemented	See text.	1992	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
HO-3: Substitution of individual oil-based furnaces	Yes*	Energy	CO2	Switch to less carbon-intensive fuels (Energy supply), Efficiency improvements of buildings (Energy consumption)	Economic, Information	Implemented	See text.	2010	Government: Danish Energy Agency	20 and IE (G1 and G4)	20 and IE (G1 and G4)	Estimates in 2017 - based on The 2013 Analysis of the Effects of Selected Measures for the National Audit Office, Danish Energy Agency, December 2013 (http://www.ens.dk/sites/ens.dk/files/energistyrelsen/Nyheder/kyoto-samlenotat_9._december.pdf (an English translation is included in Annex B3))
HO-4: Better Houses	Yes*	Energy	CO2	Efficiency improvements of buildings (Energy consumption)	Information	Implemented	See text.	2014	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
HO-5: Strategy for Energy renovation of buildings	Yes*	Energy	CO2	Efficiency improvements of buildings (Energy consumption)	Information, Education, Research	Implemented	See text.	2014	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
HO-6 (new): Heat pumps as an energy service	Yes*	Energy	CO2	Efficiency improvements of buildings (Energy consumption), Increase in renewable energy (Energy supply)	Economic	Implemented	See text.	2016	Government: Danish Energy Agency	IE (G1 and G4)	IE (G1 and G4)	
G4: All EE mitigation actions (Energy Efficiency) since 1990	Yes*	Combined (TD-b1, -2, -3, -4, -5, -6, -7; EN-1; BU-1, -2, -6, -7, -9, -10; TR-1a, -1b, -2, -3, -4, -5, -6, -7, -10, -11, -12; HO-1, -2, -3, -4, -5, -6)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	**17583**	**13231**	Estimated in September 2019 based on the energy projection from August 2019. The methodology is described in Denmark's 7th National Comminication, Annex B4.

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.5.2 CH_4 (methane)

Total emissions of methane from the energy sector account for about 1.1% of the sector's greenhouse gas emissions, corresponding to about 0.5 million tonnes CO_2 equivalents. Many small sources contribute to this overall relatively minor source of greenhouse gas emissions. The biggest single contribution comes from gas-fired CHP plants, which emit unburnt natural gas. With a view to minimising the emissions, a 1998 Statutory Order, in force from 2006 to 2013, has limited emissions of nitrogen oxides, unburnt carbon hydrides, including methane, and carbon monoxide etc.. However, the limit value for unburned hydro carbons was removed in a revision of the Statutory Order entering into force on 7 January 2013.

As of 1 January 2011 a tax on methane emissions - equal in terms of CO_2 equivalents to the CO_2 tax - from natural gas fired power plants was introduced (see chapter 4.3.3.3.).

4.3.5.3 N_2O (nitrous oxide)

Nitrous oxide accounts for 0.8%, or 0.4 million tonnes CO_2 equivalents, of the energy sector's total greenhouse gas emissions. Within energy, emissions of nitrous oxide from transport have increased since the introduction of new cars with catalytic converters in 1990. However, as the population of cars from before 1990 is almost zero today, no further increase in specific nitrous oxide emissions from cars with catalytic converters is expected.

4.3.6 Industrial Processes and Product Use (IPPU)

The greenhouse gas emissions from industrial processes and product use made up 4% of Denmark's total greenhouse gas emissions in 2017 (without LULUCF), of which CO_2 was the primary emission. 75% of the sector’s emissions are CO_2, primarily from cement production, and 24% are emissions of the industrial gases HFCs, PFCs, and SF_6.

4.3.6.1 CO_2 - Cement production

Cement production results in large emissions of CO_2. The production process itself is very energy-intensive, and a large quantity of CO_2 is emitted in connection with the production process.

Cement production in Denmark is concentrated in a single company. About half of the emissions come from the company’s energy consumption and the other half from chalk, which is one of the raw materials used in the process. A lot has been done within the cement industry. For example, in the last 20 years the Danish cement producer has significantly reduced its CO_2 emissions per tonne cement produced.

Since 2005, all CO_2 emissions from cement production in Denmark are subject to the EU ETS.

4.3.6.2 *N_2O - Production of nitric acid*

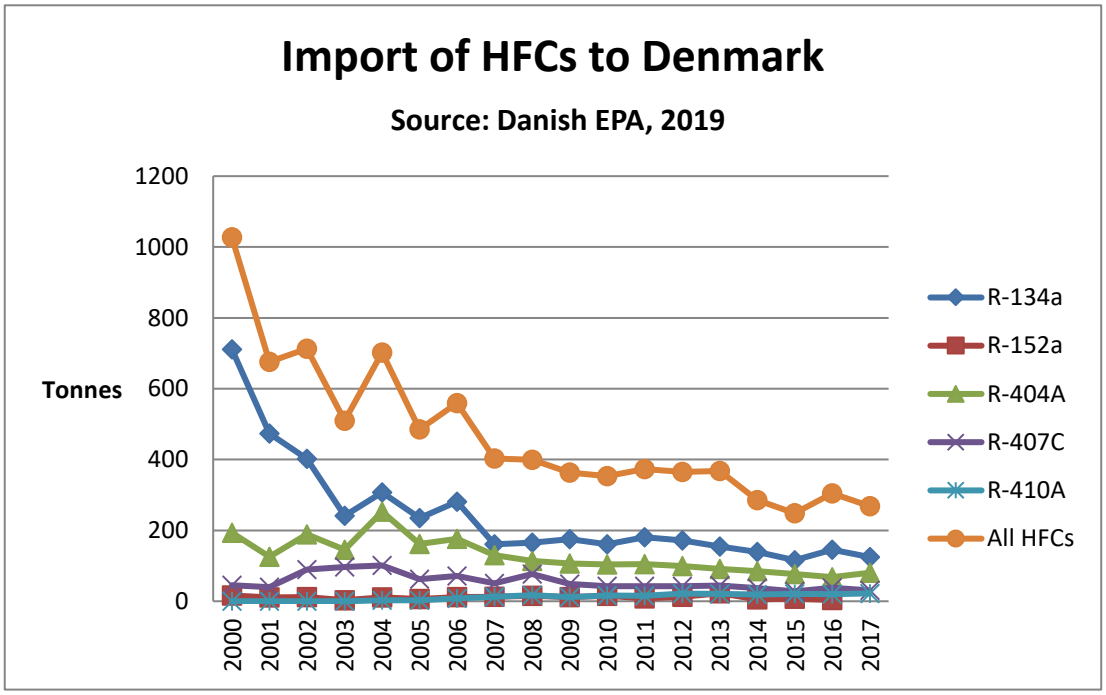
The emission of nitrous oxide (N_2O) from the production of nitric acid in connection with the production of fertilizer in Denmark has only been included in Danish emissions inventories in recent years, even though production from the single plant in Denmark, with associated emissions, has taken place for many years, including 1990, Denmark's basis year for emissions of nitrous oxide.

In summer 2004, however, the owner decided to stop production of fertilizer and so production of nitric acid in Denmark. Emissions of nitrous oxide from production of nitric acid in 2003 corresponded to 0.9 million tonnes CO_2 equivalents. In 2004 emissions were about one-half of this, and from 2005 they ceased entirely cf. market conditions for production of fertilizer in Europe.

4.3.6.3 *HFCs, PFCs and SF_6 - Consumption of these substances*

Emissions of the so-called industrial gases HFCs, PFCs, and SF_6 are in accordance with the emission inventories included in the industrial sector. This is also the case for emissions from other sectors during use and scrapping of equipment containing HFCs, PFCs and SF_6. These gases are used for several purposes including as refrigerants and blowing agents, etc. (HFCs) and insulator gas in high voltage switchgear (SF_6). Since there is no production of these gases in Denmark, all emissions are related to the import of the substances. The developments in imports of chemical mixtures containing HFCs in recent years are shown in Figure 4.10.

FIGURE 4.10 IMPORT OF HFCS TO DENMARK 2000-2017 IN TONNES HFCS
Source: Danish Environmental Protection Agency



The Danish regulation of emissions of the industrial greenhouse gases (HFCs, PFCs, and SF_6) is 2-phased, since there is a consumer tax on the use of the substances and

also a statutory order on the phasing out use of the gases in new facilities and products. Both measures are further described below.

According to model-based calculations, the combined effect of taxation and regulation of F-gases compared to a business as usual scenario starting in 2000 is an approximately 1.4 million tonnes of CO_2 equivalents reduction in annual F-gas emissions in 2020. The accumulated emission savings over the period from 2000 to 2020 is estimated at approximately 11.2 million tonnes of CO_2 equivalents.

4.3.6.3.1 Taxes on HFCs, PFCs and SF_6

Taxes corresponding to their GWP have been imposed on each of the greenhouse gases from March 2001 in combination with the Danish CO_2 tax of DKK 0.15 per kg CO_2 as described in section 4.3.3. This means that HFC-134a is subject to a tax of DKK 215/kg, as it has a GWP of 1,430. There is a ceiling of DKK 600/kg so although SF_6 has a GWP of 23,900, the tax is only DKK 600/kg and not DKK 3,585/kg.

The tax is imposed on the substances on importation because none of them is produced in Denmark. The tax is payable whether the substances are imported as pure substances or as part of imported products. If the content in the products is not known, the tax is based on a fixed tariff.

The tax is payable on a wide range of products, including:

- Refrigerating and freezing plants
- Air-conditioning plants
- PUR foam for cooling plants, district heating pipes, insulated gates and doors, panels for refrigeration and freezer rooms, extruded polystyrene for insulation (XPS foam), jointing foam
- Spray canisters
- Insulation gas

The tax is also payable on services on existing and new installations/products.

4.3.6.3.2 Regulation of HFCs, PFCs and SF_6

On 15 July 2002, a statutory order on the regulation of certain industrial greenhouse gases came into force.

This Statutory Order includes a general ban on the use of industrial greenhouse gases in a great number of new facilities and products from 1 January 2006, including household cooling and freezing appliances, PUR foam, etc. However, some products and applications are exempted from the ban. This applies, for example, to servicing existing plants, mobile cooling plants, including mobile air conditioning plants, the use of HFCs in cooling and air conditioning plants with fillings between 0.150 and10 kg HFC, SF_6 in high voltage plants, etc. The Statutory order was revised in May 2017 in order to reflect the development of new low GWP, fluorinated refrigerants such as HFOs. The only change is that the revised order does not cover HFCs with a GWP below 5. All other provisions remains unchanged. The Statutory Order was revised again in November 2018 allowing the use of HFCs in certain hermetically

sealed heat pumps in amounts up to 50 kg. The purpose of the revision was to remove barriers for the use of medium size heat pumps in the energy system.

To ensure the best possible implementation of the phase-out dates for the refrigeration sector, a total of DKK 12 million was reserved for the period 2005-2007 for development of alternatives and for subsidies for implementation of the alternatives developed in the previous years. A knowledge centre for HFC-free cooling has been established. This centre disseminates knowledge and offers technical assistance.

As from 2015 to 2017 DKK 1,5 million is reserved for promoting cooling equipment relying on natural refrigerants and retrofitting existing equipment to use refrigerants with lower GWP.

To ensure regeneration and environmentally friendly destruction of newly developed flammable fluorinated refrigerants DKK 2.5 million is granted from 2017 to 2019 to upgrade the existing return system (see Chapter 4.3.4).

In 2019 an information campaign costing 300.000 DKK aiming at preventing illegal imports of HFC is expected to be launched.

An overview of the above measures regarding industrial processes is given in table 4.20[17].

TABLE 4.20 MEASURES IN THE INDUSTRIAL PROCESSES SECTOR

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
IP-1: Regulation of use of HFCs, PFCs and SF6 (phasing out most of the uses)	Yes*	Industry/Industrial processes	HFCs, PFCs, SF6	Reduction of emissions of fluorinated gases (Industrial processes)	Regulatory	Implemented	See text.	2006	Government: Danish Environmental Protection Agency	IE (G1 and G6)	IE (G1 and G6)	
G6(new): F-gas taxes and regulation	Yes*	Combined (TD-8 and IP-1)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	800	800	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.7 Agriculture

The primary occupational sectors agriculture, forestry and fisheries are generally considered as one single economic sector in Denmark, although the importance of the individual sectors differs greatly with respect to Denmark's emissions and uptake of greenhouse gases. Agricultural farms have emissions of primarily methane and nitrous oxide as described in this section. Liming, urea application and other carbon-containing fertilizers are minor sources of CO_2 emissions. The CO_2 emissions by sources and removals by sinks in relation to Denmark's agricultural soils and forests are included under the LULUCF sector described in Section 4.3.7. CO_2 emissions from energy use in agriculture are included under energy (section 4.3.4).

In 2016, emissions of greenhouse gases from agriculture (i.e. excluding CO_2 from cropland and grassland under the LULUCF sector) were responsible for 20.9% of Denmark's total greenhouse gas emissions (total excluding LULUCF, but with indirect CO_2). Total greenhouse gas emissions from agriculture consisted, in 2016, of 52.8% from methane, 45.1% from nitrous oxide and 2.1% CO_2 emissions primarily from liming. Agriculture is the overall most important sector regarding emissions of N_2O and CH_4. In the same year, the contribution of N_2O and CH_4 from agriculture to the national total emission of these gases was 89.0% and 79.2%, respectively. N_2O emissions from agriculture decreased by 26.5% and the CH_4 emissions from agriculture decreased by 0.4% from 1990 to 2016 (*Nielsen et al., (2018a)*).

Table 4.21 shows measures for greenhouse gas emission reductions within agriculture.

Policies and measures relevant for the agricultural sector which have affected or will affect the sector's greenhouse gas emissions are:

- Ban on burning of straw on fields
- Action Plans for the Aquatic Environment I and II and Action Plan for Sustainable Agriculture
- Action Plan for the Aquatic Environment III
- Ammonia Action Plan
- Action Plan for Joint Biogas Plants and subsequent follow-up programmes, including the New Energy Policy Agreement
- Environmental Approval Act for Livestock Holdings
- Agreement on Green Growth 2009
- Agreement on Green Growth 2.0
- Subsidy for conversion of arable land on organic soils to nature
- Political Agreement on a Food and Agricultural Package and the political Agreement on Targeted Regulation and subsequent agreements [such as the national budget for 2020, which includes allocation of additional funding for afforestation and environment- and climate-technologies]
- Agreement on Nature (the Nature Package)
- Advisory task force on barriers for reducing the hydraulic retention time of manure before being delivered to biogas plants (PSO Agreement of 17 November 2016)

- National Green Climate Fund – Initiatives in agriculture 2017
- GHG accounting and awareness building at farm-level. Climate-friendly feed production for pigs. Promotion of green bio-refining. (Agreement of 2nd May 2019)
- Multifunctional Land Reparcelling Fund (Agreement of 19th September 2019).

Stronger research efforts in agriculture affecting all greenhouse gases

New solutions and new technology are needed for the production of even more climate-friendly food in the future. At the same time, there is a need to know more about how greenhouse gas emission reductions can be obtained in the best way with the technology we already have available today.

Funded by the National Green Climate Fund other research work in agriculture was initiated in 2019 as mentioned in chapter 4.3.4:

- Climate accounts and information on individual farm-level
- Climate-friendly feed production
- Promotion of green bio refining
- Promotion of green building

Further information is included in chapter 4.3.4.

In 2019, DKK 90 million was allocated for climate change mitigation research in agriculture in the period 2019-2021 and a research programme has been launched consisting of 10 projects. An additional 30 million DKK has been allocated to this initiative in 2022.

Furthermore, 40 million DKK has been allocated to climate research in agriculture in 2020 as part of the Danish Green Development and Demonstration Programme (GUDP).

4.3.7.1 ***CH_4 (methane)***

Methane emissions mainly steam from the agricultural sector, contributing, in 2016, with 79% of total Danish CH_4 emissions, corresponding to 5.6 million tonnes CO_2 equivalents (*Nielsen et al., (2018a)*). Agricultural systems have two main sources of methane. Methane is formed through enteric fermentation of feed during digestion in livestock (farm animals) and from conversion of carbon in the manure.

Danish agriculture's biggest contribution to the methane emissions comes from dairy cows.

In the digestion process, methane is a by-product of the fermentation of feed in the rumen, primarily from grass and roughage fodder such as grass, grass silage and maize silage. In addition, methane is formed by microorganisms during conversion of carbon in the manure under anaerobic conditions, increasing with increasing temperatures and pH. These conditions especially occur in manure stores and housing systems with slurry (liquid manure) or deep litter. Methane from manure management in Denmark is primarily linked to pig production.

The emission of methane from agriculture has remained more or less stable in the period from 2006 to 2017. At present, the number of dairy cows in Denmark is projected to increase slightly in combination with an increased milk production per dairy cow, which again could cause the feed intake and thus the methane emissions from enteric rumen fermentation to rise. At the same time, the CH_4 emissions from manure are expected to slightly decrease due to an increasing share of the manure expected to be treated in biogas plants or acidified in the livestock housing system (the stable). The effect on methane emissions from acidification needs further documentation.

4.3.7.1.1 Biogas

Biogas from digestion of manure and organic wastes carries a number of potential advantages when used to substitute fossil energy: reductions in emissions of greenhouse gases, better utilization of manure as fertiliser, recycling and use of organic wastes for energy and fertiliser purposes etc. However, there are also environmental challenges for example increased ammonia emission and odour from the biogas plants.

As part of the Danish Rural Development Programme 2007-2013, financial support has been provided to investments in biogas plants in 2010 and in 2012. In 2012 support was awarded to both new and existing biogas plants to the amount of DKK 262 million.

In order to stimulate expansion of the biogas sector the subsidy on the sales price of electricity production based on biogas was adjusted by the Energy Policy Agreement of 22 March 2012. The Agreement resulted in an amendment to the Promotion of Renewable Energy Act of 27 December 2008.

The Energy Policy Agreement continued funding biogas for combined heat and power (CHP) and introduced subsidy equality so that biogas sold to the natural gas grid would receive the same subsidy as biogas used at CHP plants. In addition the agreement also introduced a new subsidy when biogas is used in industrial processes, as a fuel for transport or for the production of heat.

As part of the PSO Agreement of 17 November 2016, it was decided to establish and fund an advisory task force with the aim of investigating and removing barriers for reducing the hydraulic retention time of manure before being delivered to biogas plants, and thus reduce methane emissions while increasing biogas production at the same time. The taskforce commenced their work in late 2018.

Consequently the latest projection from the Danish Energy Agency expects an increase in biogas production from 3.9 PJ in 2007 to 22,0 PJ in 2020 and 28 PJ in 2030 mainly based on agricultural sources.

The biogas production is expected to result in a reduction of the annual emissions of methane and CO_2 by approximately 0.9 million tonnes of CO_2 equivalents by 2020 including the reduced CO_2 emissions from substitution of fossil fuels, primarily natural gas. Reductions in the emission of nitrous oxide is not included in this figure as they are not well documented in the case of storage of degassed slurry. The expected effect was re-estimated in September 2016 by DCE[16].

[16] "Biogasproduktions konsekvenser for drivhusgasudledning i landbruget" Rapport nr. 197 DCE, 2016.

As mentioned in chapter 4.3.4, the 1st allocation of the budget under the National Green Climate Fund in June 2017 included an earmarking of 9,0 million DKK for developing solutions in existing biogas plants and associated suppliers of feedstock with a view to reduce the retention time of manure in the housing system prior to the treatment in the biogas plant. This is expected to increase the production of biogas per unit input of manure while at the same time reducing emissions of methane from the housing system. The expected effect of this initiative is not included in the GHG emission projection from March 2017.

As part of the 2018 energy agreement, it was decided to no longer permit new applicants to the existing subsidy schemes for the use of biogas from January 1st 2020.

In 2019 a targeted effort to reduce methane emissions from Danish biogas plants was initiated. The total reduction effect of this initiative over the period 2021-2030 is estimated at approximately 1.1 million tonnes CO2 equivalents (accumulated annual reductions).

4.3.7.2 N_2O (nitrous oxide)

Agriculture is the largest source of nitrous oxide emissions in Denmark. Of the total Danish N_2O emissions of 5.3 million tonnes CO_2 equivalents in 2016, 89% or 4.8 million tonnes of CO_2 equivalents came from agriculture (*Nielsen et al., (2018a)*). The process of emission of N_2O occurs in some types of manure storage facilities and during conversion of mineral and organic bound nitrogen (e.g. in manure and applied wastewater sludge) in the soil. Some of the leached nitrogen is also converted into nitrous oxide. Nitrogen entering the soil with applied fertiliser and manure, and through plant residue, is the main sources of nitrous gas emissions.

Likewise, ammonia (NH_3) volatilisation contributes to the greenhouse effect because some of the ammonia nitrate ends up as nitrous oxide in the atmosphere. Ammonia volatilisation into the atmosphere stems almost exclusively from agriculture, through conversion processes from manure, fertiliser, sludge, crop residue and treatment of straw with ammonia. In particular, the emissions occur during handling of manure in animal housing, during storage and transport of manure, and from grazing animals[17] (*Nielsen et al., (2018a)*).

The main reason for the drop in the overall emissions of N_2O from the agricultural sector of 25% from 1990 to 2017 is enforced legislation (see below) to reduce nitrogen leaching by improving the utilisation of nitrogen binding in manure, as well as measures to reduce the application of mineral fertilizers to soils. The legislation has resulted in a considerable reduction in the use of mineral fertilisers. It has also helped, that the market driven effort to improve the feeding efficiency (and thereby also the farmers economy) have reduced the nitrogen excreted per unit livestock produced. The basis for the N_2O is then reduced (*Nielsen et al., (2017a)*). Implementation of the Action Plans

[17] Mikkelsen et al., 2005: Mikkelsen, M.H., Gyldenkærne, S., Poulsen, H.D., Olesen, J.E. & Sommer, S.G. (2005). Opgørelse og beregningsmetode for landbrugets emissioner af ammoniak og drivhusgasser 1985-2002. Arbejdsrapport fra DMU Nr. 204 (in Danish).

for the Aquatic Environment II and III contribute the most to this reduction[18,19]. Further projected decrease in N_2O emissions towards 2020 is mainly attributed to areas being taken out of agricultural production for urban development and infrastructure etc., and to anticipated increased shares of organic agriculture (DCE, December 2014).

In 2016, the Political Agreement on a Food and Agricultural Package from 2015) allowed Danish farmers to use more nitrogen in the fields through a lifting of the reduced fertilizer standards for nitrogen. The potential slight increase in future N_2O emissions resulting from this policy change is sought mitigated by correspondingly implementing measures for ensuring optimization of N-binding and carbon sequestration in agricultural soils (e.g. catch crops).

4.3.7.2.1 Action Plans for the Aquatic Environment I and II and Action Plan for Sustainable Agriculture

One of the main purposes of the Action Plans for the Aquatic Environment and the Action Plan for Sustainable Agriculture was to reduce agriculture's nutrient losses to the aquatic environment.

The action plans was implemented as regulation of farmers' behaviour. The Action Plan for the Aquatic Environment I was initiated in 1987, and the Action Plan for Sustainable Agriculture in 1991. In particular, these action plans included requirements concerning closed periods for applying slurry, ensuring a better utilisation of manure as well as minimum slurry storage capacity, mandatory incorporation of manure into the soil shortly after application, and winter green fields. The Action Plan for the Aquatic Environment II from 1998 contained a number of additional measures, including re-establishment of wetlands, afforestation, agreements on environment friendly agricultural measures, establishment of organic farming on an additional 170,000 ha, improved utilization of fodder, reduced animal density, use of catch crops, reduced fertilisation norms, and increased efficiency in use of nitrogen in manure. The aim of the political plans, which has now been reached, was to reduce nitrogen leaching by 100,000 tonnes N/year up to the year 2003[20]. The benchmark for the evaluation of the agricultural nitrogen leaching, as part of the final evaluation of the Action Plan for the Aquatic Environment II in December 2003, was 311,000 tonnes N per year. The evaluation showed that measures already implemented in addition to the measures agreed upon and financed by Action Plan II would result in a reduction of the total nitrogen leaching from agriculture (root zone and stable and storage facilities) of around 149,000 tonnes N per year. This corresponds to a reduction of around 48% of 311,000 tonnes N. After taking into account the calculation uncertainties, the nitrogen discharge reduction goal of 49% was achieved.

Specifically, these action plans have reduced the emissions of nitrous oxide. There have presumably also been small effects on methane emissions from manure stores, particularly as a consequence of increased use of anaerobic fermentation of manure in biogas plants and the reduced use of deep litter. The increased use of catch crops and

[18] Olesen et al., 2004: Olesen, J.E., Petersen, S.O., Gyldenkærne, S., Mikkelsen, M.H., Jacobsen, B.H., Vesterdal, L., Jørgensen, A.M.K., Christensen, B.T., Abildtrup, J., Heidmann, T. & Rubæk, G. (2004). Jordbrug og klimaændringer - samspil til vandmiljøplaner. DJF rapport Markbrug nr. 109. (in Danish).

[19] Olesen, 2005: Olesen, J.E. (2005). Muligheder for reduktion af drivhusgasemissioner i jordbruget. I: Olesen, J.E. (red). Drivhusgasser fra jordbruget - reduktionsmuligheder. DJF rapport Markbrug nr. 113, s. 12-32. (in Danish).

[20] Grant et al., 2000: Grant, R., Blicher-Mathiesen, G., Jørgensen, V., Kyllingsbæk, A., Poulsen, H.D., Børsting, C., Jørgensen, J.O., Schou, J.S., Kristensen, E.S., Waagepetersen, J. & Mikkelsen, H.E. (2000). Vandmiljøplan II - midtvejsevaluering. Miljø- og Energiministeriet, Danmarks Miljøundersøgelser, Silkeborg, Denmark. 65 pp (in Danish).

larger overall areas with organic farming would also be expected to an increased storage of carbon in the soil.

Most of the changes in nitrous oxide emissions from agriculture through the period since 1990 can be attributed to these action plans. However, it has been calculated that even without the action plans there would have been a reduction in emissions, although to a much lesser extent, due to an overall optimization and improvement of farming techniques and management practices. The effect of these action plans on emissions of nitrous oxide has been calculated at about 2.2 million tonnes CO_2 equivalents/year[19]. There are no estimates of the effect of the Action Plans I and II for the Aquatic Environment and the Action Plan for Sustainable Agriculture on carbon storage in the soil.

4.3.7.2.2 The Ammonia efforts

Ammonia emitted from agriculture will stimulate emissions of nitrous oxide when it is deposited in other ecosystems. Reducing ammonia emissions will therefore also result in a reduction of nitrous oxide emissions from that step in the production system. However, as the reduced ammonia emissions increase the nitrogen content in the manure, more nitrogen will, depending on the regulation, be applied to agricultural soils, increasing ammonia as well as nitrous oxide emissions during application. Together with the Action Plans for the Aquatic Environment I, II and III, the Ammonia Action Plan, which was adopted in 2001 carried a projected reduction of ammonia emissions by an estimated 15-20,000 tonnes of nitrogen annually. Hence, ammonia evaporation from agriculture should be reduced from 90,000 tonnes of nitrogen in the mid-1990s to approximately 60,000 tonnes of nitrogen in 2004.

The measures covered by the Ammonia Action Plan are:

1) Optimisation of manure handling in stables for cattle, pigs, poultry and fur animals.
2) Rules on covering storage facilities for solid manure and slurry tanks.
3) Ban on overall surface spreading and reduction of the time from field application of manure to incorporation in soil.
4) Ban on ammonia treatment of straw.

Following from an ex-ante analysis in 2001, these measures were estimated to have lowered the level of annual emissions of nitrous oxide corresponding to 34,000 tonnes of CO_2 equivalents from 2010. A shorter period of exposure for spread manure was estimated to have the greatest effect with an estimated reduction of 13,000 tonnes of CO_2 equivalents in annual emissions[22].

According to the latest emission inventory[21] a 22 per cent decrease in emissions of ammonia from agriculture from 2001 to 2016 can be seen – corresponding to a reduction of 75,000 tonnes CO_2 equivalents in annual N_2O emissions. From 1990 there was a 43 percent decrease in 2016 - corresponding to a reduction of 200,000 tonnes CO_2 equivalents in annual N_2O emissions. The level of approximately 60,000 tonnes of nitrogen in emissions of ammonia from agriculture projected to be reached in 2004 was reached in 2011.

[21] http://cdr.eionet.europa.eu/dk/eu/nec_revised/inventories/envwovdkw/

In 2019, further measures to reduce emissions of ammonia from agriculture was implemented. However, the effect on greenhouse gas emissions is estimated to be neutral.

4.3.7.2.3 Action Plan for the Aquatic Environment III and the agreements of Green Growth

With the political agreement on the Action Plan for the Aquatic Environment III (APAE III) of 2 April 2004, a number of measures were implemented to follow up on the results attained via the previous plans. This third action plan contains targets with respect to nitrogen, phosphorus, sensitive natural areas, and slurry odour. It is a 10-year agreement, and was, in 2008 and 2011, evaluated with respect to the Water Framework Directive and the Habitats Directive. Special emphasis in the APAE III was on the use of catch crops, stricter requirements for use of manure as well as afforestation and agro-environmental measures. In addition, the agreement includes research initiatives aimed at slurry odours and reduction of emissions of nutrients, e.g. research into technology to manage slurry, ammonia etc. The effect of the action plan for the period 2008-2012 was projected at 0.2 million tonnes CO_2 equivalents/year[22].

In 2008 the APAE III was evaluated on results, adequacy of tools and economic aspects to ensure that activities and expected results were achieved. The main conclusions for a number of measures were that implementation and effects have not been as anticipated. At the midterm evaluation of the APAE III, covering the years 2004-2007, no reductions in the production of animal manure were recorded, nor any decrease in the use of mineral fertilizers. Furthermore, no significant reductions in nitrogen leaching were proved for the investigated period (Waage Petersen et al., 2008).Thus, no change in the key parameters that provided reduction in the emissions of greenhouse gasses in the earlier action plans for the aquatic environment have happened so far, and it may therefore be difficult to reach the initial target.

In 2009, the Danish government launched the Green Growth Agreement (GGA) – as a plan for ensuring better conditions for nature and the environment while allowing agriculture to develop as a business. The GGA is a long-term plan for Danish nature, environment and agriculture with the purpose of ensuring that a high level of environmental, nature and climate protection goes hand in hand with modern and competitive agriculture and food industries.

The GGA was augmented in 2010 by the Green Growth Agreement 2.0, containing a series of initiatives to improve agriculture and food sector growth conditions and thus help to secure employment on farms, in the food industry and downstream industries. Furthermore, the GGA 2.0 supported the ongoing development of bioenergy with the aim of contributing to support Denmark's target of 30 per cent renewable energy by 2020 and fulfilment of Denmark's climate goals.

The GGA contains targets with respect to discharges of nitrogen and phosphorus to the aquatic environment, protection of nature and biodiversity, development of renewable energy in the agricultural sector including biogas plant, reduction of harmful pesticides,

[22] Olesen et al., 2001: Olesen, J.E., Andersen, J.M., Jacobsen, B.H., Hvelplund, T., Jørgensen, U., Schou, J.S., Graversen, J., Dalgaard, T. & Fenhann, J. (2001). Kvantificering af tre tiltag til reduktion af landbrugets udledning af drivhusgasser. DJF-rapport Markbrug 48. (http://web.agrsci.dk/djfpublikation/djfpdf/djfm48.pdf , in Danish).

development of the organic sector and strengthened initiatives within research and development within the agricultural and food sectors.

The GGA also dealt with the problems previously encountered in achieving the expected goals through the APAE III. The measures in the GGA likewise pursued the achievements of the objectives of the Nitrates Directive on reducing discharges of nitrogen and phosphorus, as the target in APAE III were included in the GGA target. Different from the former APAE's were also the switch from a target on N leaching from the root zone to a target on N discharge to the aquatic environment. As the GGA worked to implement the EU Water Framework Directive, some measures were targeted sub-catchment while some measures were general rules.

The initiatives incorporated in the GGA were projected to reduce the agricultural sector's overall emissions of greenhouse gases by about 800,000 tonnes of CO_2 equivalents annually. Of this, about 400,000 tonnes reduction were expected to be derived from a green, market-based re-structuring of nitrogen regulation.

The latest estimate of achieved effects of the GGA, as well as of structural developments in agriculture etc., used in the October 2014 WEM greenhouse gas emission reduction projection amounts to 0.5 Mt of CO_2 eq. annually by 2021 (DCE, December 2014). A joint evaluation of the GGA's and the APAE's March 2014 showed an overall reduction effect of approx. 0.19 Mt CO_2 eq. annually for the period of 2007-2011, and approx. 0.337 Mt CO_2 eq. annually for 2012-2015. The reduction of specific emissions for 2007-2011 equals annually an estimated 4 Kt CO_2 eq. from CH_4, 67 Kt CO_2 eq. from N_2O, 107 Kt CO_2 eq. from carbon storage, and 11 Kt CO_2 eq. stemming from reductions in fuel use. Likewise, for the period of 2012-2015 the reductions equals an estimated 179 Kt CO_2 eq. from N_2O, 129 Kt CO_2 eq. from carbon storage, and 41 Kt CO_2 eq. stemming from reductions in fuel use, while emissions stemming from CH_4 rose with 12 Kt CO_2 eq.[23] (DCA 2014).

4.3.7.2.4 Environmental Approval Act for Livestock Holdings

The Environmental Approval Act for Livestock Holdings was implemented on 1 January 2007, providing national minimum requirements for environmental protection (odour, ammonia, nitrate, phosphorous, landscape, etc.) when livestock holdings are established, expanded or changed. The purpose of the Act was also to ensure the use of best available techniques (BAT).

The measures covered by the Environmental Approval Act for Livestock Holdings in 2007 were:

- 300 m buffer zones around ammonia-sensitive areas where no extension of livestock farms can take place if such an extension would lead to increased ammonia deposition in natural areas vulnerable to ammonia.
- Demand for a general reduction of ammonia emissions relative to a production facility with the lowest ammonia emission norm: 2007: 15%, 2008: 20%, 2009: 25%.

[23] DCA (2014): Shelde, K. & J. E. Olesen. Klimaeffekt af kvælstofvirkemidler i dansk landbrug i perioden 2007-2015. Report on evaluation of GHG effects ordered from the Danish Ministry of Agriculture and Fishery (in Danish).

- Demands for injection of animal slurry on black soil and grass within buffer zones (1 km from vulnerable natural areas and, from 2011, in the whole country).
- Demand for fixed cover on most new containers for solid manure and slurry tanks (if they are within a distance of 300 meter to neighbours or vulnerable natural areas).
- Environmental standards and limits for nitrate-leaching to surface waters and groundwater depending on vulnerability, e.g. denitrification capacity and standards for phosphorous surplus depending on soil type and drainage.
- Environmental standards and limits for maximum deposition of ammonia on vulnerable nature and maximum odour impact on neighbours and cities.

The effect of these measures on greenhouse gas emissions has not yet been quantified.

The Environmental Approval Act for Livestock Holdings was changed in 2011, and the environmental standards for ammonia were heightened trough several measures. The general reduction goal was increased to a reduction of 30%, the specific ammonia reduction requirements were introduced with a maximum for total deposition to certain ammonia sensitive areas. This replaced the 300 meter buffer zones. In general this led to an overall tightening of the ammonia reduction with local exceptions.

4.3.7.2.5 Political Agreement on a Food and Agricultural Package and the political Agreement on Targeted Regulation and subsequent agreements

In 2015 the Green Growth Agreement was replaced by the Political Agreement on a Food and Agricultural Package (FAP) which ensures better production conditions for farming, while at the same time handling a number of the key environmental challenges.

The agreement includes a diverse package of measures designed to make a shift in the way environmental regulation in the agricultural sector is carried out, from a general regulation to a targeted approach. The fertilization standards for the agricultural sector was lifted to the level of economic optimum and a new targeted regulation based on specific environmental goals for the aquatic environment and ground water resources is introduced from 2019.

The re-establishment of wetlands, rewetting of organic soils and afforestation (conversion of arable land) remain important measures to reduce the loss of nitrogen to the aquatic environment. As a part of the Political Agreement on a Food and Agricultural Package a comprehensive support scheme for catch crops was also introduced. The agreement also included changes to the regulation on the use of catch crops in Danish agriculture: a requirement of catch-crops as compensation for livestock-related nitrogen leaching and additional catch-crops as part of a targeted regulation. The aforementioned regulatory schemes on catch crops were implemented in addition to the already existing two other schemes, covering mandatory catch crops and catch crops as part of the EU requirement of environmental focus area.

Demands on growing catch crops (primarily grass) in the autumn to reduce the nitrate leaching do also sequester CO_2. Based on plans for future agricultural regulations the area is expected to increase significantly towards 2021. In 2018 an additional agreement on Targeted Regulation was agreed upon. In addition to catch crops measures such as energy crops, reduced fertilizer/manure application, fallow land etc. was introduced as a

part of the scheme. Money was also allocated to develop technologies from biorefining from grass with the aim of commercializing green bio refining and thus increase the demand for grass and other crops with lower climate- and environmental footprint.

Most recently, a political agreement (November 2019) has been reached on frontloading the positive climate and nutrient effects of targeted regulation from 2021 to 2020. From 2019 to 2020 there will be a substantial increase in agricultural land with catch crops (potentially 550,000 hectares out of a appx 2,6 mill. hectares of arable farmland). As a part of targeted regulation, the farmer can choose a number of alternative measures to catch crops to mitigate nutrient leaching. From 2020, all alternative measures have a positive climate effects.

As a part of the Political Agreement on a Food and Agricultural Package money was also allocated for afforestation, environmental and climate technologies and conversion of arable land on organic soils to nature under the Danish Rural Development Programme funded by the European Agricultural Fund for Rural Development (EAFRD). As a part of the agreement on the national budget of 2020, an additional 35 mio. DKK have been allocated for afforestation purposes and 170 mio. DKK for investments at farm-level, including environmental and climate technologies.

4.3.7.2.6 Subsidy for conversion of arable land on organic soils to nature

Cultivated organic soils emits large amounts of CO_2. In Demark approximately 66,000 hectares of organic soils (>12% organic carbon) are under agricultural practice.

In 2014 the Danish Government adopted a subsidy scheme for conversion of arable land on organic soils to natural habitats under the framework of the common agricultural policy (CAP). This scheme is now a part of the Agreement on the Food and Agricultural Packet.

The objective of the scheme is to reduce agricultural emissions of greenhouse gases from organic soils through less intensive agricultural operations. The initiative also offers opportunities for synergies in relation to reduced discharges of nitrogen into watercourses, lakes and fiords as well as for increased biodiversity. From 2015 to 2017 the plan has been to provide economic subsides to convert approximately 2,500 hectares of organic lowland areas into rewetted natural habitats and reduce emissions of greenhouse gases. The CO_2 effect has been estimated at a reduction of at least 33.000 tonnes of CO_2-eq. annually in the period 2014-2017. The effect is likely to be greater due to prioritization of projects with the lowest emission reduction costs (DKK per kg CO_2), depending on soil types[24]. The areas under the subsidy scheme are registered with a ban on cultivation, fertilisation and pesticide application. As a part of the Agreement on the Food and Agricultural Packet the scheme has been extended to 2020. The scheme is co-financed by the Danish rural development by the European Agricultural Fund for Rural Development (EAFRD).

In September 2019 an Agreement was made on establishing a Multifunctional Land Re-parcelling Fund 2019-2021. The objective is to facilitate re-parcelling of land and thereby obtain synergies between agricultural production and biodiversity, climate, environment, recreation and rural development.

[24] DCE (2014): Jensen, P.N. (red). Fastsættelse af baseline 2021. Effektvurdering af planlagte virkemidler og ændrede betingelser for landbrugsproduktion i forhold til kvælstofudvaskning fra rodzonen for perioden 2013-2021. DCE technical report no. 43.

4.3.7.2.7 Political Agreement on Nature

A Political Agreement on Nature (the Nature Package) was installed in May 2016 with the main aim of supporting an increased protection of biodiversity. The agreement states initiatives within the following areas: Biodiversity in forests, continued initiatives for nature (initiatives derived from the former plan Danish Nature Policy), nature and biodiversity, urban nature and outdoors recreation, open land management and the farmer's role as resource manager of nature areas, modern nature conservation, and simplification of legislation.

As a result of the nature package 10.200 acres of forest is designated as untouched forest and another 3.600 acres is designated as forest in which management primarily is based on biodiversity considerations in state-owned areas. Also government grant scheme has been established to increase areas of untouched forest in private owned forests.

The climate effect of this Agreement has not been established.

4.3.7.2.8 Bio-refining

Bio-refining can produce a range of products such as inputs to biogas production, protein and fodder and other higher value products for use in e.g. the chemical and pharmacological industry. As mentioned in chapter 4.3.4, the 1st allocation of the budget under the National Green Climate Fund in June 2017 included an earmarking of 8 million DKK as support in 2017 for pilot-scale bio-refinery projects based on non-food biomass. Commercialization of the bio-refining sector can facilitate demand for crops such as grasses with higher associated environmental and climate benefits than for conventional crops like corn or cereals. In addition, bio-refining is considered to be essential in realizing the bio-economy potential within Danish agriculture and other connected sectors.

In 2019, additional funds have been allocated through the National Green Climate Fund for promotion of green bio refining (see chapter 4.3.4).

4.3.7.2.9 Promotion of precision agriculture.

Preparation of pilot project on precision farming to investigate to what extend high-tech solutions such as sensors and GPS data can optimize cultivation with regard to nitrogen leacing was initiated in 2019. There are potentially positive climate mitigation effects from precision farming. However, more knowledge beyond the existing initiative is needed in order to quantify the effect. The potential outcome will be integrated in future work on climate.

TABLE 4.21 MEASURES IN AGRICULTURE, FORESTRY AND FISHERIES (SEE ALSO TABLE 4.25 (LULUCF))

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
AG-1(expired): Action Plan for the Aquatic Environment I+II and Action Plan for Sustainable Agriculture	Yes*	Agriculture	N2O	Reduction of fertilizer/manure use on cropland (Agriculture)	Regulatory	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	1987	Government: State, Local: Municipalities	**1900**	**1900**	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).
AG-2(expired): Action Plan for the Aquatic Environment III	Yes*	Agriculture	N2O	Reduction of fertilizer/manure use on cropland (Agriculture)	Economic, Regulatory	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2004	Government: State, Local: Municipalities	IE (G1)	IE (G1)	
AG-4a/4b/4c/4d/4e: Reduced emissions of ammonia	Yes*	Agriculture	N2O	Reduction of fertilizer/manure use on cropland (Agriculture), Improved animal waste management systems (Agriculture)	Regulatory	Implemented	See text.	2001	Government: State, Local: Municipalities	IE (G1)	IE (G1)	
AG-4f: Environmental Approval Act for Livestock Holdings	Yes*	Agriculture	N2O, CH4	Reduction of fertilizer/manure use on cropland (Agriculture), Improved livestock management (Agriculture), Improved animal waste management systems (Agriculture)	Regulatory	Implemented	See text.	2007	Government:State, Local:Municipalities	IE (G1)	IE (G1)	
AG-6: Biogas plants	Yes*	Agriculture, Energy	CO2, CH4	Improved animal waste management systems (Agriculture), Increase in renewable energy (Energy supply), Switch to less carbon-intensive fuels (Energy supply)	Economic	Implemented	See text.	1987	Government: State	**240**	**207**	2020: "Biogasproduktions konsekvenser for drivhusgasudledning i landbruget" Rapport nr. 197 DCE, 2016 (http://dce.au.dk/udgivelser/vr/nr-151-200/abstracts/nr-197-biogasproduktions-konsekvenser-for-drivhusgasudledning-i-landbruget/); 2030: Preliminary estimate (to be published, in Danish).
AG-9(expired): Agreement on Green Growth	Yes*	Agriculture, Energy	N2O, CO2, CH4	Reduction of fertilizer/manure use on cropland (Agriculture), Increase in renewable energy (Energy supply), Switch to less carbon-intensive fuels (Energy supply)	Economic, Regulatory	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2009	Government: State	500	0	The estimate for 2020 shown here is a former separate estimate for this measure. As this measure has been replaced by measure no. AG-12, only the effect estimated under AG-12 is included in the calculation of the total effect of all measures.
AG-11(new+expired): Agreement on Green Growth 2.0	Yes*	Agriculture, Energy	CO2, CH4, N2O	Increase in renewable energy (Energy supply), Reduction of pesticides use (), Reduction of tax on productive farmland (), Conversion to organic farming ()	Economic, Regulatory	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	2010	Government: Ministry of Environment and Food	0	0	Notat nr. 2, Vedrørende effekter af forskellige tiltag i forbindelse med Grøn Vækst, Aarhus Universitet (http://pure.au.dk/portal/files/38211855/010511_DJF_DMU_notat_2_inkl_Baselineg ruppens_kommentarer_og_sp_rgsm_l.pdf , in Danish)
AG-12(new): Political Agreement on a Food and Agricultural Package	Yes*	Agriculture	N2O, CO2	Improve the ability of the food and agricultural industry to increase primary production and exports, as well as to contribute to creating growth and jobs, in due interaction with protection of nature and the environment. ()	Economic, Regulatory	Implemented	See text.	2016	Government: Ministry of Environment and Food	**-122**	**-122**	Answer to question no. 391 (ord. part) asked by the parliament's Committee for Environment and Food on 15 Januar 2016 (http://www.ft.dk/samling/20151/almdel/mof/spm/391/svar/1299227/1598927/index.htm , in Danish)
AG-13(new): Agreement on Nature (the Nature Package)	Yes*	Agriculture, Forestry/LULUCF	CO2, CH4, N2O	Protection of biodiversity through increased involvement of farmers in land use planning, simplification of related legislation etc. (), Protection of biodiversity through increased involvement of farmers in land use planning, simplification of related legislation etc. ()	Regulatory	Implemented	See text.	2016	Government: Ministry of Environment and Food	IE (G1)	IE (G1)	

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.8 LULUCF (Land-Use, Land-Use Change and Forestry)

4.3.8.1 *CO_2 – emissions and removals in LULUCF under the Climate Convention*

The emission of GHGs from the LULUCF sector (Land Use, Land Use Change and Forestry) includes primarily the emission of CO_2 from land use and small amounts of N_2O from disturbance of soils not included in the agricultural sector.

The LULUCF sector is subdivided into six major categories:

- Forest
- Cropland
- Grassland
- Wetlands
- Settlements
- Other Land

Forests and forestry are important due to CO_2 sequestration and emissions as a consequence of trees growing, respiring and decomposing. Danish forests contain a considerable store of CO_2 absorbed from the atmosphere. When new forests are established, new CO_2 stores are created. Afforestation is therefore a useful climate policy instrument.

The total sector has been estimated to be a net source of 0-8 % of the total Danish emission incl. LULUCF (average 2013-2017). The average emission in 2013-2017 has been estimated to 2313 kt CO_2 equivalents with an emission of 2971 kt CO_2 equivalents in 2017.

Emissions/removals from the sector fluctuate based on specific conditions in the given year. In general, the forest sector has been a net sink, while Cropland and Grassland have been net sources. The latter due to a large area with drained organic soils. Emissions from drained organic agricultural soils accounts for approximately for 6-7 % of the total Danish emission incl. LULUCF in the latter years (this estimate is under revision).

In years where the total sector accounts to approximately zero, the forest and/or the agricultural mineral soils are net sinks. Forest has shown to be a large sink until 2014 and turned into a small net source in 2015 and 2016. In 2017, Forest was a small sink. Since 2013, Forest has been estimated to be an accumulated net sink of 5397 kt CO_2 equivalents. In 2017, Cropland has been estimated to be a net source of 4.7 % of the total Danish emission incl. LULUCF. This is mainly due to a large area with cultivated organic soils. Grassland is a net source contributing to 1.5 % of the total Danish emission. This is also due to a large area with drained organic soils (the estimated size of this area is under revision). Emissions from Cropland have shown a continuous decrease since 1990 with 47 % and the emission from Grassland has decreased with 22 %. However, large variations occur between years.

Forest policies

The political measure to increase carbon sequestration is the objective from the National Forest Programme (2002): “Forest landscapes should cover 20-25% of Denmark after one tree generation (80-100 years)” – and the scope and potential for

natural habitats and processes should be strengthened in this effort. This measure relates to Article 3.3 of the Kyoto Protocol. Various measures have been taken towards achieving this goal as shown in Table 4.25[17]. For instance, a government grant scheme has been established as an incentive for afforestation on private agricultural land. Also, the state itself is establishing new forests, and some private individuals are establishing forests on agricultural land without a government grant. Through rural planning and differentiated incentives, afforestation is particularly encouraged in certain priority areas in order to pursue multiple forest functions and values, implementing the water framework directive and including recreation and ground water protection.

In October 2018 the Danish Ministry for Environment and Food launched a new National Forest Programme. It sets out a long term vision and two long term goals related to expansion of forest cover and biodiversity conservation, 13 strategic orientation lines as well as a number of concrete actions for a multifunctional and sustainable development of Danish forests.

The vision is “A forest area in growth with healthy and robust forests which accommodate diversity and which provide for good opportunities for sustainable timber production, which create jobs, take care of biodiversity and preserve natural treasures, mitigate climate change, protect groundwater and offer great outdoor experiences - in new and old forests and for the benefit of both present and future generations”.

The long term goal for forest cover reads: “Before the end of the 21st century, forested landscapes cover 20-25 pct. of Denmark's total area”. Thus, the goal relates to “forest landscapes”, which constitutes all forests and some surrounding areas as well. However, a precise definition of forest landscapes has not been developed. The Danish forest area is currently 14.5 pct. of the land cover.

Many strategic orientation lines relates to climate and energy, most notably those below.

Under the header “More forest and less global warming”:

- Increase the Danish forest area and increase the public utility of the new forests.
- Increase the uptake and stocks of carbon in forests and wood products through sustainable management.

Under the header Sustainable production:

- A favourable and clear framework for sustainable production of timber and other goods.
- Increase the demand and supply of documentable sustainable timber.
- Uniform, robust and operational criteria for "sustainable timber".
- Continue the conversion and development of close to nature forestry.

Forest carbon estimations

In the estimation of carbon pools and emissions from existing forests, afforestation and deforestation in 1990 to 2015, the information collected in relation to different forest census and inventories is combined with the satellite-based land use/land cover

map for the base year 1990, 2005 and 2011. Hereby, consistent estimates of emissions from existing forests are obtained utilising as much information from the data sources as possible and providing best possible time series. To estimate the forest area satellite-based land use/land cover maps have been used for 1990, 2005 and 2011. From 2012 and onwards actual vector data are used.

Estimates of woody biomass carbon pools are obtained by applying species specific biomass functions developed for the most important tree species in Denmark (Skovsgaard et al. 2011; Skovsgaard and Nord-Larsen, 2012, Nord-Larsen and Nielsen 2015) to individual tree measurements in the National Forest Inventory plots. For tree species where no biomass function is available, stem volumen for conifers and the total above-ground volumen for deciduous trees are calculated using species specific volume or form factor functions. Subsequently, total stem or above ground biomass is calculated by multiplying the volumes with species specific basic densities for the wood. The estimated biomass is converted into total above-ground and below-ground biomass by multiplying with expansion factors calculated from expansion factor functions for beech and Norway spruce as representatives of deciduous and coniferous species (Skovsgaard et al. 2011; Skovsgaard and Nord-Larsen, 2012). The quantity of carbon is calculated by multiplying by the conversion factor of 0.5 tonnes C/tonne dry matter.

Estimation of deadwood carbon pools follows the calculations stated above except that a conversion factor is applied according to the degree of decomposition of the wood.

Estimation of carbon pools in the forest floor (litter) is based on measurements of the depth of the litter layer on the National Forest Inventory plots. As peat lands are reported specifically, a maximum depth of 15 cm is used in the calculations. Forest-floor carbon for individual species is estimated by multiplication of the forest floor depth by the plot area, a species-specific density (Vesterdal & Raulund-Rasmussen, 1998) and the ground cover fraction of the individual species. Calculation of ground cover fraction is based on the proportion of basal area of the individual species and total forest-floor carbon is estimated by summation of forest-floor carbon of the different species.

For estimation of carbon pools in the mineral soil, average carbon content for different soil types (loamy, sandy and organic) were applied to the individual National Forest Inventory plots according to their soil types determined from Danish soil mapping. The average soil carbon contents used in this analysis were obtain in a forest soil inventory in which it was documented that forest mineral soil is not an overlooked source of CO_2 emissions. In a study, analysis of time series data did not reveal any changes in forest mineral-soil carbon pools observed in 1990 and 2007-2009.

A more detailed record of the calculations of carbon pools are provided by Nord-Larsen and Johannsen (2016)[25].

[25] Nord-Larsen, T., & Johannsen, V. K. (2016). Danish National Forest Inventory: Design and calculations. Department of Geosciences and Natural Resource Management, University of Copenhagen. (IGN Report). http://static-curis.ku.dk/portal/files/164970017/Danish_National_Forest_Inventory.pdf

Table 4.22 shows the total area reported under Forest Land (FL) under the Convention. The area with FL has increased since 1990 due to an intensive afforestation programme. In the beginning of the 1990's, approximately 3000 ha were afforested every year. In recent years, approximately 1900 ha are afforested per year. The estimated emission from organic matter varies between years. Mineral soils are a small sink due to the afforestation. The CO_2 emission from organic soils is slightly reduced over time due to rewetting of the organic soils in the forests.

TABLE 4.22 AREA AND ANNUAL EMISSIONS 1990 TO 2017 FROM FOREST LAND.

Source: Denmark's National Inventory Report 2019 and University of Copenhagen - Department of Geosciences and Natural Resource Management

Area and emissions	1990	2000	2010	2013	2014	2015	2016	2017
Area								
Forest Land Area (1000 ha)	548.7	590.8	627.7	637.3	637.3	637.5	637.5	638.6
Emissions								
Living and dead biomass, kt C	-185.9	-185.4	-481.	-843.2	-840.3	-616.9	-29.8	216.5
Litter, kt C	-17.9	-17.8	-544.9	159.3	-218.8	614.0	174.4	-372.5
Dead wood, kt C	-4.8	-4.8	-43.8	-23.0	-69.7	1.6	0.0	81.9
Mineral soils, kt C	-0.6	-7.1	-12.6	-12.4	-11.9	-11.6	-11.2	-10.7
Organic soils, kt C	52.6	50.2	45.7	47.0	47.1	47.3	47.4	47.5
Total, kt C	-156.6	-165.0	-1037.1	-672.2	-1093.6	44.3	230.8	-37.4
CH4, kt CH4	0.2	0.7	1.1	1.2	1.2	1.2	1.2	1.2
N2O, kt N2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total, kt CO2 eqv.	-542.5	-562.5	-3750.9	-2412.1	-3957.1	215.4	899.5	-83.8

Information on the accounting of emissions and removals related to forest activities according to the Kyoto Protocol accounting rules is included in chapter 4.3.8.2.

Carbon sequestration in afforestation is stored in the total living biomass (incl. roots) of the trees. Forests raised on agricultural land accumulate far more biomass than the previous agricultural land-use. The forest biomass contains about 50% carbon, which is absorbed as CO_2 through photosynthesis. Probably, additional carbon is stored in the organic matter in the soil following afforestation of cropland due to a larger supply of dead organic matter and the absence of soil preparation. Denmark reported on sequestration in litter (forest floors) developing after conversion from agriculture to forestry while mineral soil C stocks are reported as unchanged based on field measurements. Previous studies did not indicate any consistent change in mineral soil C stocks (*Vesterdal et al., 2002, 2007*).

The effect of afforestation on other greenhouse gases, such as nitrous oxide and methane has recently been studied in Denmark (*Christiansen and Gundersen, 2011*). The acidification of nitrogen-rich former agricultural land may stimulate the formation of nitrous oxide, and blocking of drains after afforestation and the resulting water stagnation could increase methane emissions. The recent projects have shown that methane uptake in soils is in fact increased following afforestation of well-drained soils, although only in oak stands, while methane uptake was unchanged in Norway spruce (*Christiansen and Gundersen, 2011*). In more wet afforested areas, methane may be emitted when drainage pipes stop working (*Christiansen et al., 2012*). Nitrous oxide emissions increased with time since afforestation in both oak and spruce stands (*Christiansen and Gundersen, 2011*). Increased methane and nitrous oxide emissions could to some degree counteract the positive effect of afforestation on CO_2 sequestration. However, since information is

still scarce on changes in the methane and nitrous oxide emissions, analyses of the consequences of afforestation are only carried out for CO_2.

The continued growth of new forests will provide for carbon sequestration on a long-term basis. Owing to the legal protection of forest land use, the sequestration in subsidised afforested land is expected to be permanent. If the objective of increasing the forest area is to be achieved, however, an enhanced rate of planting will be needed. Afforestation offers many other benefits in addition to CO_2 sequestration. Conversion of farmlands into forest reduces the loss of nitrogen to the aquatic environment. Besides playing a major role in protecting the aquatic environment from nitrogen afforestation provides valuable groundwater protection and protection of habitats for fauna and flora. Forest is also a highly valued type of nature in terms of cultural values and landscape amenity and has great value for outdoor recreation. In addition to carbon sequestration, afforestation thus contributes to a wide range of values.

4.3.8.2 CO_2 – emissions, removals and credits from Activities under Articles 3.3 and 3.4 of the Kyoto Protocol

In 2007, a research and monitoring programme for the monitoring and reporting activities under Articles 3.3 and 3.4 was decided with a total budget of DKK 72 million. The results from this programme have been included in the annual reporting of greenhouse gas inventories under the UNFCCC and the Kyoto Protocol since April 2010 and the final results are approved under the Kyoto Protocol with the publication of the inventory review report on 4 February 2015.

A new research and monitoring programme has been launched to cover the 2nd commitment period 2013-2020.

The results from these programmes are further described in the following sections.

In 2019, an analysis to improve the monitoring and accounting of carbon dioxide uptake and storage in soils and forests was initiated. The estimation of carbon sequestration in soils and forests is extremely complex. Therefore an analysis to improve the estimation methodologies to better target increases in CO_2 sequestration has been initiated.

4.3.8.2.1 Article 3.3

In accordance with Article 3.3 of the Kyoto Protocol, emissions and removals from afforestation, reforestation and deforestation (ARD) activities have been included in the accounting of Removal Units (RMUs) in the 1st commitment period 2008-2012 under the Protocol. The total accounted quantity in the 1st commitment from ARD was a net loss of 255.9 Gg. Mainly due to a low growth rate in the afforested areas and a high deforestation rate (Submission to UNFCCC in April 2014 and UNFCCC inventory review report of 4 February 2015).

In total for the first 5 years of the 2nd commitment period afforestation, reforestation, and deforestation (ARD) activities has been estimated to a net sink of approximately 949 Gg CO_2-equivalent or in average 190 Gg CO_2-equivalent per year.

No reforestation was recorded in in the 1st commitment period or the first 5 years of the 2nd commitment period.

4.3.8.2.2 Article 3.4

In accordance with Article 3.4 of the Kyoto Protocol, emissions and removals from forest management (FM), cropland management (CM) and grazing land management (GM) activities have been elected to be included in the accounting of RMUs in the 1st and 2nd commitment period under the Protocol.

Forest management

According to the final estimates for the 1st commitment period (2008-2012) (*Nielsen et al., 2014* and the *Inventory Review Report* published on 4 February 2015), average CO_2 removals from Forest Management amounted to 4050 Gg. The included carbon pools were above-ground and below-ground biomass, dead wood and soil. This estimate was much higher than the specified maximum of credits as removal units for Denmark at 183 Gg CO_2 (50Gg C) annually in 2008-2012.

In 2017 the preliminary removal for forest management for the years 2013 to 2017 has been estimated to 4638 Gg CO_2-eq or equivalent to 928 Gg CO_2-eq in average per year (Nielsen *et al., 2019*). This combined with a Forest Management Reference Level (FMRL) of 407 Gg as inscribed in the appendix of the annex to decision 2/CMP.7 and a preliminary technical correction of -82.6 Gg (Nielsen *et al., 2019*) gives a preliminary net accounting of 6270 Gg CO_2-eq or equivalent to 1254 Gg CO_2-eq in average per year from Forest Management in 2013-2017.

Emissions from forest management may originate from an increased harvesting caused by an uneven age distribution such as observed for beech in Denmark. However, the observed emissions origins from a lower sequestration in living biomass than usually observed and an unexplained loss of carbon in the forest litter pool.

Harvested wood products (HWP)

Carbon emissions from harvested wood products (HWP) have been reported since 2013. Denmark has chosen to report under Approach B, the production approach, which refers to equations 12.1, 12.3 and 12.A.6 of volume 4 of the 2006 IPCC Guidelines and the 2013 Supplementary GPG.

According to a questionnaire on the production of the Danish wood industry, the production of sawnwood in 2017 was about 686.000 m^3, while the production of woodbased panels was about 428.000 m^3, which both are an increase compared to 2016. The questionnaire covered an estimated 90 % of the revenue generated in the sawnwood sector and 100 % of the sector revenue for wood-based panels (there were only two relevant companies). A cross validation of the roundwood consumption showed an average deviation of 8 % for 2011-2013 between the Questionnaire and the figures reported by Statistics Denmark based on harvest and trade statistics. As of 2017, the HWP pool originating from domestic harvest and domestic consumption consisted of about 5 million tonnes carbon (67 % from sawnwood and 33 % from wood-based panels – the paper pool was insignificant). This is equivalent to 13 % of the carbon stock in live forest biomass. If imported wood were also included, the pool increases to about 29 million tonnes carbon equivalent to 75 % of the carbon stock in live forest biomass. The total inflow of carbon to the HWP pool in 2017 is

reported to about 164.000 tonnes carbon - 64.000 tonnes from sawnwood and 100.000 tonnes from woodbased panels. The outflow from the pool is reported to about 115.000 tonnes carbon in 2017 - 66.000 tonnes from sawnwood and 49.000 tonnes carbon from wood-based panels. Thus, there has been a net carbon sequestration in HWP of about 44.000 tonnes carbon in 2017. See Table 4.23.

The estimate of the size of the total HWP stock is quite uncertain, as the empirical basis for the FOD model and the attached half-lives is weak. Conducting direct inventories of the carbon stock may be a method to reduce uncertainty. In the Danish case, estimates based on the FOD model for the total HWP pool, including imported wood and converted to finished wood products actually came quite close, when measured per capita, to estimates from Finland originating from a direct inventory. Regarding estimates for pool changes, uncertainty on half-life may be of less importance, as longer retention time in the pool may be traded off against higher emissions levels from the historic pool. This depends on the characteristics of the pool, i.e. the size of the pool vs. the recent inflow. Uncertainty on activity data relates to both uncertainty on measurements, e.g. caused by reporting errors, and statistical uncertainty, caused by variation in the sampled population.
Judging from the coverage and the validation results, surveying the production of semi-finished wood products in Denmark by questionnaire has been successful. It will be repeated in the following years as part of the future reporting of HWP.

TABLE 4.23. HWP IN USE FROM DOMESTIC HARVEST (CRF TABLE 4.GS1).

Source: Denmark's National Inventory Report 2019

HWP produced and consumed domestically (ΔC HWPdom IU DH)	HWP in use from domestic harvest				Net emissions/ removals from HWP in use
	Gains	Losses	Half-life	Annual Change in stock (ΔC HWP IU DH)	
	(t C)		(yr)	(kt C)	(kt CO_2)
Total	**190140.0**	**-145822.6**		**44.3**	**-162.4**
1. Solid wood	190140.0	-145735.3		44.4	-162.7
Sawn wood	74927.3	-77765.3	35.00	-2.8	-10.4
Wood panels	115212.7	-67970.0	25.00	47.2	-173.1
2. Paper and paperboard	NO	-87.4	2.00	-0.1	0.3

Cropland management and Grazing land management:

In 2006, the government at that time decided to include removals of CO_2 by soils (Article 3.4 of the Kyoto Protocol) in the calculation of Denmark's climate accounts under the Kyoto Protocol.

From 1990 to the 1st commitment period 2008-2012 Cropland management and Grazing land management has shown a net reduction in greenhouse gas emissions of 7697 Gg CO_2-equivalents or in average 1539 Gg CO_2-equivalents per year.

From 1990 to the first five years of the 2nd commitment period, i.e. 2013-2017, Cropland management and Grazing land management has shown a net reduction in emissions of 10119 Gg CO_2-eq. or in average of 2024 Gg CO_2-equivalents per year.

Contributions to the Kyoto Protocol under Article 3.4 concern changes to vegetation and soil carbon stocks. Under the Kyoto Protocol, the flows of carbon to and from biomass and soils are stated according to a net-net principle by which the change in net emissions is calculated as the rate of change for the carbon stock in the 1st and 2nd commitment period less the rate of change for the carbon stock in the reference year (1990). As elected land cannot leave an elected activity, emissions from areas, which have been converted from Cropland and Grassland to Wetlands and Settlements in the commitment periods, are included in the accounting. For agriculture, the following potential sources of CO_2 emissions and CO_2 sequestration have been included:

1. Net change in the content of carbon in mineral soils in connection with changed land use and cultivation.

2. Net change in the soil's carbon stock in connection with drainage and cultivation of organic soils or re-establishment of wetlands.

3. Change in the carbon content of wood biomass in wind breaks and fruit farms.

The agricultural mineral soils has shown to be a steady increasing sink. This is primarily due to increased yields, better management, ban on straw burning, statutory requirements for catch crops, etc.

One of the measures with an effect on return of carbon to the soil has been the ban on burning of straw residues on fields as shown in Table 4.25.

The ban has resulted in greater return of carbon to the soil, and therefore increased carbon storage in the soil, as well as increased use of straw as a fuel. Both uses will result in a net reduction in CO_2 emissions. Not burning straw prevents the methane and nitrous oxide emissions associated with the burning. On the other hand, there are some emissions of nitrous oxide in connection with the return of nitrogen to the soil when the straw is mulched.

The measure works by regulating behaviour, and the ban was introduced from 1990. The measure was implemented in the form of a statutory order under the Environmental Protection Act. Ban on field burning is a part of cross compliance under EUs Common Agricultural Policy.

Demands on growing catch crops (primarily grass) in the autumn to reduce the nitrate leaching do also sequester CO_2. The area today is approximately 440.000 hectares or approximately 16 % of the agricultural area.

The agricultural yields are projected to increase in the future due to a shift in the fertilizer regulation from 2015. Higher yields will result in a higher amount of crop residues returned to soil and secondary increase the soil carbon stock.

Another measure which will increase sequestration in woody biomass is the planting of windbreaks also mentioned in Table 4.25. The objective of planting windbreaks has primarily been to reduce wind erosion and ensure greater biodiversity. Planting of windbreaks has been supported under conditions described in the Statutory Order on Subsidies for Planting Windbreaks and Biotope-improving Measures (Statutory Order no. 1101 of 12/12/2002). Support has been granted under the EU Rural Districts Programme. For the period 2017-2019 windbreaks will be established under the political agreement of May 2016 called "Naturpakken" and will focus primarily on ensuring greater biodiversity. Since the end of the 1960s about 1,000 km of tree-lined windbreaks have been planted with government subsidies. It is also estimated that about 30% more has been planted without subsidies. Estimates indicate that planting of windbreaks leads to CO_2 sequestration in woody biomass of about 130,000 tonnes CO_2/year[26].

Total from activities under Articles 3.3 and 3.4

The total amount of net RMU credits from activities under Articles 3.3 and 3.4 is estimated at 8.6 million RMUs (or tonnes of CO_2-equivalents) for the whole period 2008-2012 or as the average per year 1.7 million RMUs.

The total preliminary amounts of net RMU credits under Articles 3.3 and 3.4 has been estimated to 17.3 million RMUs (or tonnes CO_2-equivalents) in the first five years of 2nd commitment period or in average 3.5 million RMUs per year.

Further information on the accounting of emissions and removals related to activities under Articles 3.3 and 3.4 under the Kyoto Protocol is included in Table 4.24.

[26] Gyldenkærne et al, 2005: Gyldenkærne, S., Münier, B., Olesen, J.E., Olesen, S.E., Petersen, B.M. & Christensen, B.T. (2005). Opgørelse af CO_2-emissioner fra arealanvendelse og ændringer i arealanvendelse. Arbejdsrapport fra DMU (under preparation,, in Danish).

TABLE 4.24. INFORMATION ON ACCOUNTING FOR ACTIVITIES UNDER ARTICLES 3.3 AND 3.4 OF THE KYOTO PROTOCOL

Source: Denmark's National Inventory Report 2019

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Base Year(2)	NET EMISSIONS/REMOVALS									Accounting parameters	Accounting quantity (4)
		2013	2014	2015	2016	2017	2018	2019	2020	Total(3)		
	(kt CO2 eq)											
A. Article 3.3 activities												
A.1. Afforestation/reforestation		8,56	-341,86	-620,66	27,58	-600,50				-1526,89		-1526,89
Excluded emissions from natural disturbances(5)		NA	NA	NA	NA	NA				NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)												
A.2. Deforestation		38,51	116,33	252,32	147,38	23,67				578,20		578,20
B. Article 3.4 activities												
B.1. Forest management										-4637,98		-6269,90
Net emissions/removals		-2546,39	-3774,33	667,52	677,72	337,49				-4637,98		
Excluded emissions from natural disturbances(5)		NA	NA	NA	NA	NA				NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)												
Any debits from newly established forest (CEF-ne)(7),(8)		NA	NA	NA	NA	NA				NA		NA
Forest management reference level (FMRL)(9)											409,00	
Technical corrections to FMRL(10)											-82,62	
Forest management cap(11)											19822,07	-6269,90
B.2. Cropland management (if elected)	4470,10	2043,95	3152,12	2608,81	2854,47	2429,18				13088,53		-9261,95
B.3. Grazing land management (if elected)	1000,51	844,01	954,02	783,29	789,24	775,17				4145,74		-856,83
B.4. Revegetation (if elected)	NA	NA	NA	NA	NA	NA				NA		NA
B.5. Wetland drainage and rewetting (if elected)	NA	NA	NA	NA	NA	NA				NA		NA

TABLE 4.25 MEASURES IN THE LAND-USE, LAND-USE CHANGE AND FORESTRY SECTOR (LULUCF)

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
LU-1: Ban on burning straw on fields	Yes*	Forestry/LULUCF	CO2	Conservation of carbon in agricultural soils and reduction of air pollution. ()	Economic	Implemented	See text.	1989	Government: State, Local: Municipalities	IE (G7)	IE (G7)	
LU-2: Planting of windbreaks	Yes*	Forestry/LULUCF	CO2	Enhancing carbon sequestration through planting of windbreaks ()	Economic	Implemented	See text.	1960	Government: Ministry of Environment and Food	IE (G7)	IE (G7)	
LU-3: Subsidies scheme for private afforestation on agricultural land (increase the forest area in Denmark)	Yes*	Forestry/LULUCF	CO2	Afforestation and reforestation (LULUCF), Strengthening protection against natural disturbances (LULUCF)	Economic	Implemented	See text.	1991	Government: Danish Environmental Protection Agency	IE (G7)	IE (G7)	
LU-4: Public afforestation (state and municipalities)	Yes*	Forestry/LULUCF	CO2	Afforestation and reforestation (LULUCF), Strengthening protection against natural disturbances (LULUCF)	Regulatory, Voluntary Agreement	Implemented	See text.	1989	Government: Danish Environmental Protection Agency, Local: Municipalities	IE (G7)	IE (G7)	
LU-5: Subsidy for conversion of arable land on organic soils to nature	Yes*	Forestry/LULUCF, Agriculture	CO2, N2O	Reduction of fertilizer/manure use on cropland (Agriculture), Prevention of drainage or rewetting of wetlands (LULUCF)	Economic	Implemented	See text.	2015	Government: Ministry of Environment and Food	IE (G7)	IE (G7)	
G7(new): LULUCF activities	No	Combined (LU-1, -2, -3, -4 and -5)	Combined	Combined	Combined	Combined	Combined	Combined	Combined	1740	1740	Estimates by DCE, 2017 (http://dce2.au.dk/pub/SR244.pdf).

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.

4.3.9 Waste

The direct contribution of the waste sector to greenhouse gas emissions consists primarily of methane from the decomposition of organic waste that takes place at landfill sites. Greenhouse gas emissions from wastewater treatment included both methane (85%) and nitrous oxide (14%) in 2017. Out of the total greenhouse gas emissions from the waste sector of 1.1 million tonnes CO_2 equivalents in 2017 – corresponding to 2.4% of total Danish greenhouse gas emissions – the proportion from landfills was 57%, from compost production 20%, from wastewater treatment 15%, from biogas plants 6% and 2% from other minor sources such as accidental fires.

Please note that all incineration of waste in Denmark is associated with energy utilisation, which is why the emission of CO_2 from the incineration of plastic waste is included under the energy sector.

4.3.9.1 ***CH_4 (methane)***

In previous years, efforts within the waste sector have been based on the Action Plan for Waste and Recycling 1993-97, which included targets on waste treatment up to the year 2000. The plan did not relate directly to the waste sector's contribution to methane emissions (CH_4), but included a number of initiatives that are of relevance to waste products containing industrial gases (HFCs and SF_6), besides an objective concerning stopping landfilling combustible waste.

Nor did the subsequent waste plan, Waste 21, which covers the period 1998-2004, relate directly to the waste sector's possibilities for contributing to solution of the problem of greenhouse gas emissions. The plan aimed at stabilising the total quantities of waste in 2004, and increasing recycling and reducing the environmental burden from the environmentally harmful substances in waste, including the industrial gases. With respect to waste incineration, the objective was to adjust incineration capacity to what was absolutely necessary to ensure best possible energy utilisation, maximum CO_2 displacement and regional self-sufficiency. The plan thus contributed indirectly to reduction of greenhouse gas emissions.

The objective in Waste 21 was for 64% of all waste to be recycled, 24% to be incinerated and not more than 12% to be landfilled.

That objective was already reached in the year 2000, and according to the Danish Environmental Protection Agency's Waste Statistics 2000 (ISAG) total waste in that year amounted to about 12.8 million tonnes.

Waste Strategy 2005-08 was issued in September 2003. The Waste Strategy aimed at decoupling growth in waste amounts from economic growth. The Strategy also aimed at preventing the loss of resources in waste and environmental impacts from waste, as well as better quality waste treatment and an efficient waste sector. Finally, the strategy aimed at reducing waste amounts sent to landfill to 9% in 2008 and increasing recycling to 65% of all waste.

The most important initiatives regarding greenhouse gases in the Strategy were improvement of landfills and increased collection of plastic packaging for recycling.

The first part of the Waste Strategy 2009-12 was issued in March 2009 and the second part was issued in June 2010. The recycling target for all waste was still 65%, and the target for overall waste amount sent to landfills was reduced to 6%.

The current waste strategy (*Denmark without Waste I + II*) reflects a general change of focus in Denmark to considering waste as a resource. The Danish waste strategy includes 1) a Resource Strategy and a Resource Plan for waste management which focuses on increasing recycling and 2) a Waste Prevention Strategy.

The Resource Strategy and the Resource Plan for waste management 2013-18 (*Denmark without Waste I*) includes a goal of 50% recycling of seven fractions (organic, paper, cardboard, glass, plastic, wood and metal) of household waste in 2022. The strategy focuses also on organic waste from households and the service sector, recovery of metals etc. in waste electrical and electronic waste (WEEE) and shredder waste, construction and demolition waste and phosphorous in sewage sludge.

It is estimated that the initiatives in the strategy will lead to a decrease in the amount of incinerated waste (820.000 tonne less in 2022).

The Waste Prevention Strategy (*Denmark Without Waste II*) 2015-20 includes a number of initiatives with a special focus on food waste, textiles, electronic equipment, packaging and construction.

Both the Resource Strategy for Waste Management and the Waste Prevention Strategy have the purpose of keeping materials and products in circulation thus reducing primary production of materials and products, which is often energy demanding. The two strategies thus lead to indirect greenhouse gas savings, which are not directly quantifiable.

The latest figures for waste in Denmark are in the Danish EPA Waste Statistics 2017. Total waste (primary waste, excluding soil) in 2017 was 11.7 million tonnes of which 68% was recycled, 29% incinerated, and 3% landfilled.

The waste sector's contribution to the direct reduction of greenhouse gas emissions consists mainly in:

- banning the landfilling of organic waste,
- utilising gas from closed as well as existing landfills,
- optimising the oxidation of methane gas in landfill covers (biocovers),
- recovery of shredder waste from landfills.

On the top of this there are measures that indirectly reduce greenhouse gas emissions:

- increasing recycling of plastic-, paper-, cardboard-metal-, WEEE-, wood-, and glass-waste, that will substitute primary production of materials
- using waste (except for plastics) as an energy source in dedicated incineration plants
- digestion of organic waste to produce biogas.

An overview of the detailed measures implemented in the pursuance of these objectives is given in Table 4.26[27]. The emission of methane from Danish landfills is calculated to have been 71,000 tonnes gross in 1990, decreasing to approximately 33,800 tonnes in 2013, corresponding to a 52 per cent reduction.

As a consequence of the municipal obligation to assign combustible waste to incineration, from 1 January 1997, methane emissions from the Danish landfills will continue to decrease in the years ahead.

According to the Danish Energy Authority's inventory Biogas, Production, Forecast and Target Figures, there were 25 gas plants at Danish landfills in 2002. These installations produced 10,000 tonnes of methane annually, compared to approx. 1,700 tonnes in 1993. In 2004, methane recovery from landfills amounted to 7,700 tonnes methane[28]. The same study shows that, through optimising existing gas plants, a further 1,800 tonnes methane per year could be recovered over the next five years. Furthermore, the establishment of new gas-collection equipment at five landfills could contribute with additional 1,300 tonnes methane per year over the next five years.

However, optimisation of existing plant and establishment of new gas plants will probably require subsidies. The previous subsidy scheme to promote gas collection at landfills was discontinued at the end of 2001.

Only a few landfill gas plants are expected to be established in the future. The maximum quantity of methane recovered peaked in 1998 at about 13,200 tonnes. The quantity of methane recovered will continue to fall gradually over many years.

The total quantity of waste incinerated rose from 2,216,000 tonnes in 1994 to 3,335,000 tonnes in 2017, i.e. an approximately 50% increase. This is a slight decrease compared to 2006 where 3,489,000 tonne of waste was incinerated. The energy produced from the non-fossil part of waste used as fuel in the incineration plants is included as part of the renewable energy production in the Danish energy statistics. The international greenhouse gas inventories include greenhouse gases from incineration of the content of oil-based products, such as plastics in waste.

In accordance with the targets in the waste strategies, waste incineration plants are designed so as to optimise energy utilisation.

Besides the direct effect of waste management on greenhouse gas emissions, the emissions are also affected indirectly through recycling of paper, cardboard, plastic, metals, etc. which means less energy consumption and thus less CO_2 emissions during production of raw materials and new products.

The implementation of national waste plans and fulfilment of targets has necessitated the implementation of a wide range of measures.

In 1996 the Statutory Order on Waste was amended to introduce a municipal obligation to assign combustible waste to incineration (corresponding to a stop for disposal of

[27] Following the three sub-tables cf. Annex XI in "COMMISSION IMPLEMENTING REGULATION (EU) No 749/2014 of 30 June 2014 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) No 525/2013 of the European Parliament and of the Council" (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0749&from=EN) and displaying the current content of the EEA database on EU Member States' policies and measures (PaMs).

[28] Willumsen, 2004

combustible waste at landfills). As a result of this, large quantities of combustible waste that used to be disposed of at landfills are now either recycled or used as fuel in Danish incineration plants.

Besides the traditional regulation via legislation, statutory orders, and circulars, the waste sector is regulated by means of a range of policies and measures, including taxes and charges, grant schemes and agreements.

A tax on landfilling and incineration of waste was introduced in Denmark in 1987. Since 1993 the tax has been differentiated to reflect the political priorities of the different forms of treatment. It thus costs most to landfill waste, less to incinerate the waste and nothing in tax to recycle waste. The waste tax has been increased several times and today (November 2018) the waste tax is DKK 475 per tonne waste disposed of at landfills. With effect from 1 January 1999, the so-called waste heat tax introduced as part of the Coal Tax Act (see chapter 4.3.3.1.1). The waste heat tax was introduced in connection with increases in general taxes on fossil fuels to avoid giving too much incentive in favour of waste-based heat production, and to counteract the increased incentive for incineration of waste instead of recycling. From 1 January 2010, energy from waste incineration imposed waste heat tax,. The taxes thus provides an incentive to recycle as much of the waste produced as possible and to use non-recyclable, combustible waste as fuel in energy production instead of disposal of the waste at landfills.

Weight-and-volume-based taxes (e.g. on various packaging and carrier bags) encourage a reduction in packaging consumption and thus the quantities of waste. The weight-based tax is based on an index that reflects the environmental burden of the materials used.

Under the Danish EPA's "Programme for Cleaner Products etc.", grants were made for projects that reduced the environmental burden in connection with development, production, sale and use of products or in connection with the management of the waste generated during the product's entire lifecycle. Furthermore, support could be granted to waste projects aiming at reducing the problems in connection with disposal of waste. A total of approximately DKK 100 million for the part of the programme related to waste was allocated for the 5-year period 1999 to 2003.

In 2005 the Programme for Cleaner Products etc. was replaced by the Danish government's "Enterprise Scheme" which refunds CO_2 taxes to business. The waste part of this programme was aimed exclusively at enterprises. A total of DKK 33 million for the five-year period 2004 to 2008 was earmarked for the waste part of the scheme. The subsidies were to be used to reduce the environmental impact of waste.

In 2005, the Danish EPA also supported initiation of a development project aiming at documenting the oxidation of methane in landfill biocovers. By applying covers mainly consisting of compost, optimal oxidation in covers can be ensured and methane emissions from landfills can be reduced. If the reduction can be documented it can be credited to the CO_2 accounts. This bio-cover project was carried out by the Technical University of Denmark with funding from the EU LIFE Programme. The bio-cover project has established a viable methodology for documentation of the reduction of greenhouse gas emissions gained by installation of a bio-cover system on a landfill. The methodology consists of a logical order of tasks using well documented measuring technologies. The demonstration project also proved that several obstacles

may occur in relation to the biocovers on landfills which can prevent an efficient greenhouse gas reduction, and the project has obtained an understanding of which precautions should be taken.

The most important obstacles are:
a) Ability to control point gas releases,
b) Ability to distribute the landfill gas to active parts of the bio-cover system, and
c) Ability to obtain a spatially even gas distribution to active parts of the bio-cover.

Due to the obstacles the goal of reaching a 90% reduction of the methane emission was not reached; the obtained reduction was in the 20-30% range.

To address the obstacles and to improve the method, another biocover-project was initiated in 2007 as part of the Enterprise Scheme. The project was performed on another landfill, and was taking the identified difficulties into account. A reduction of the methane emission of 79-93 % was reported in the project.

Based on the promising results of the latest large scale biocover-project combined with a low shadow price, approximately 180 mio. DKK has been allocated to a Subsidy programme for biocovers at landfill sites. The subsidy programme is expected to run from 2016 – 2019, and the estimated reduction in methane-emission in the year 2021 is 300,000 t CO_2-equivalents. The actual methane-emission reduction will be assessed when the subsidy programme is finalized.

In 2007 subsidies from the enterprise scheme were given for establishing methane recovery and test pumping at 11 landfill sites. The results were reported in 2011 and showed a reduction of the emission of methane over a five year period equalling 84,435 tonnes of CO_2 equivalents.

The goal in the EU Packaging Directive of increasing the collection of plastic packaging waste for recycling to 22.5% was met in 2008 through an amendment to the Statutory Order on Waste requiring municipalities to improve the possibilities of people and enterprises to separate and deliver plastic packaging waste for recycling. This meant an increase in recycling of about 12,000 tonnes in 2012 compared to 2008.

Furthermore, producer responsibility obligations have been introduced concerning waste electrical and electronic equipment (WEEE) and batteries due to new EU Directives resulting in higher collection and recycling rates of these used products. The aim is to increase recycling of metals significantly, resulting in energy savings compared to extraction and refining of virgin materials.

On the basis of the EU Landfill Directive, demands on the establishment and operation of landfills in Denmark have been tightened with Statutory Orders No. 650 of 29 June 2001, No. 252 of 31 March 2009, No. 719 of 24 June 2011 and No. 1049 of 28th of August 2013 on landfills. According to the Statutory Orders on landfills, methane in landfills for mixed waste must be monitored. From landfills where significant amounts of biodegradable waste are disposed of, methane gas must be managed in an environmentally-sound way.

An amendment to the Statutory Order on Waste in 2000 means that municipalities should assign non-recyclable waste PVC and impregnated wood to landfill. The objective was to avoid adding PVC and impregnated wood to incineration with the consequential pollution of flue gas and slag. According to the current Statutory Order

on Waste (2018), the municipalities shall ensure that recyclable and non-recyclable PVC is collected. Recyclable PVC should be recycled whereas non-recyclable PVC should be assigned to landfill. Impregnated wood should be collected and landfilled, unless the municipality classify the waste wood as suitable for material recovery or incineration. Today, most impregnated wood is classified as suitable for incineration and exported to incineration with energy recovery in Germany.

It is not possible to make a quantitative estimate of the effects of the various measures for the waste area. The objectives in the national waste plans are related to waste amounts and their treatment. The developments are monitored through the annual waste statistics. However, changes in the treatment of waste cannot immediately be converted into changes in emissions of greenhouse gases.

TABLE 4.26 MEASURES IN THE WASTE SECTOR

Name of mitigation action	Included in with measures GHG projection scenario	Sector(s) affected	GHG(s) affected	Objective and/or activity affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2 eq)**		Source of estimates
										2020	2030	
WA-1: A ban of landfill of combustible waste.	Yes*	Waste management/waste	CH4	Reduced landfilling (Waste), Waste incineration with energy use (Waste), Enhanced recycling (Waste)	Regulatory	Implemented	See text.	1997	Local: Municipalities	**333**	**333**	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).
WA-2: The waste tax	Yes*	Waste management/waste	CH4	Reduced landfilling (Waste)	Economic, Fiscal	Implemented	See text.	1987	Government: Ministry of Taxation	IE (G1)	IE (G1)	
WA-3: Weight-and-volume-based packaging taxes	Yes*	Waste management/waste	CO2, CH4	Demand management / reduction (Waste)	Economic, Fiscal	Implemented	See text.	2014	Government: Ministry of Taxation	IE (G1)	IE (G1)	
WA-4: Subsidy programme – Enterprise Scheme (special scheme for businesses)	Yes*	Waste management/waste	CH4	Demand management / reduction (Waste)	Economic	Implemented	See text.	2004	Government: Ministry for the Environment	IE (G1)	IE (G1)	
WA-5: Increased recycling of waste plastic packaging	Yes*	Waste management/waste	CO2	Enhanced recycling (Waste)	Regulatory	Implemented	See text.	1994	Government: Danish Environmental Protection Agency	IE (G1)	IE (G1)	
WA-6: Implementation of the EU landfill directive	Yes*	Waste management/waste	CH4	Improved landfill management (Waste)	Regulatory	Implemented	See text.	1999	Government: Danish Environmental Protection Agency, Local: Municipalities	IE (G1)	IE (G1)	
WA-7(expired): Support for (construction of facilities for) gas recovery at landfill sites	Yes*	Waste management/waste	CO2, CH4	Enhanced CH4 collection and use (Waste)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	1984	Government: Danish Energy Authority	**205**	**205**	Estimates in 2017 - based on The 2005 Effort Analysis (http://www2.mst.dk/udgiv/publikationer/2005/87-7614-587-5/pdf/87-7614-588-3.pdf and http://www2.mst.dk/Udgiv/publikationer/2005/87-7614-589-1/pdf/87-7614-590-5.pdf (summary in English included in Annex B2)).
WA-8(expired): Subsidy programme for cleaner products	Yes*	Waste management/waste	CH4	Demand management / reduction (Waste)	Economic	Implemented (and Expired - but included as it is expected to have influenced the level of total Danish	See text.	1999	Government: Ministry for the Environment	IE (G1)	IE (G1)	
WA-9: Subsidy programme for biocovers on landfills	Yes*	Waste management/waste	CH4	Improved landfill management (Waste)	Economic	Implemented	See text.	2017	Government: Danish Environmetal Protection Agency	**300**	**179**	Estimates by the Danish Energy Agency, March 2017 - based on "Virkemiddelkatalog, Tværministeriel arbejdsgruppe, August 2013, Klima-, Energi- og Bygningsministeriet" (https://ens.dk/sites/ens.dk/files/Analyser/virkemiddelkatalog_-_potentialer_og_omkostninger_for_klimatiltag.pdf)
G1(changed): Group of all policies and measures except in the LULUCF sector	Yes*	Combined (TD-b1, -2, -3, -4, -5, -6, -7, -8, -9; EN-1, -2, -3, -4, -5, -6; BU-1, -2, -6, -7, -8, -9, -10; TR-1a, -1b, -2, -3, -4, -5, -6, -7, -8, -9, -10, -11, -12; HO-1, -2, -3, -4, -5, -6; IP-1; AG-1, -2, -4a-f, -6, -9, -11, -12, -13; WA-1, -2, -3, -	Combined	Combined	Combined	Combined	Combined	Combined	Combined	Combined	**50671**	**75288**	Calculated as the sum of the effects estimated for G3, G4, TD-9, TR-12, G6, AG-1, AG-6, AG-12, WA-1, WA-7 and WA9.

* In principle included in the "with measures" projection scenario - not necessarily with separate annual estimates, but in most cases as a result of the assumption that the measure has contributed to the observed level of total Danish greenhouse gas emissions in the most recent historical inventory year used as the starting point for the projections.

** Estimated annual effects in 2020 and 2030 of measures implemented or adopted since 1990 - i.e. emission reductions and avoided emission increases since 1990.