MILJØMINISTERIET

Miljøstyrelsen

Annex II

The Strategic Plan on Air Pollution

14.06.2008

Clean air for all

- **action on air pollution**

Miljøstyrelsen • Strandgade 29 • 1401 København K
Tlf. 72 54 40 00 • Fax 33 32 22 28 • CVR 25798376 • EAN (drift)5798000863002 (tilskud)5798000863019 • mst@mst.dk • www.mst.dk

Foreword

We must all be able to breathe outdoors without worrying about air pollution. This applies regardless of whether we live in rural areas or in towns and cities, or are out and about in the countryside.

In Denmark, the open air has become cleaner in the vast majority of places. The clean air efforts of recent decades have a great many success stories to offer. For example, the phasing out of lead in petrol in the 1980s and the introduction of catalytic converters in petrol cars in the 1990s have led to cleaner air in towns and cities. Yet we have not reached our destination in all areas. Air pollution still represents a challenge – particularly for our health.

The government has launched a number of national measures to reduce air pollution. We have given the largest cities the opportunity to create environmental zones in which older lorries and buses are required to have particulate filters. We have exempted new passenger cars and light commercial vehicles with particulate filters from vehicle registration tax. We have lowered the tax on sulphur-free petrol. We have introduced environmental standards for wood-burning stoves. This is to name but a few examples. Since our government came in, we have earmarked more than DKK 100 million for combating air pollution, which covers subsidies for particulate filters, and the development and testing of eco-efficient technologies, for example environmentally friendly wood-burning stoves.

The government is also working on a number of other areas with the potential, directly or indirectly, to have a positive impact on air pollution, for example those of climate, transport and energy, and also research and development. These areas are, and will continue to be, an essential part of the overall clean air efforts.

Air pollution is also a cross-border phenomenon. For example, approximately two thirds of particulate pollution is carried here from abroad. Therefore, the government is also working towards ambitious, yet realistic, environmental objectives within the EU and internationally, for example within the International Maritime Organization (IMO), where Denmark has recently helped adopt a substantial tightening of the environmental standards for shipping – including, in particular, stricter requirements for air pollution from ships sailing in coastal waters.

The conditions, and therefore the challenges, are constantly changing. The use of wood for domestic heating is on the increase, and there are more and more diesel cars on the roads. This means that, in some areas, it is a challenge to meet our international commitments to a healthy, clean air environment. Therefore, there is still need for targeted action beyond the general and ongoing efforts to reduce air pollution.

In the following pages, I shall introduce a strategy that reinforces and focuses the efforts to reduce outdoor air pollution in Denmark. At the same time, the strategy gives an overview of the government's action in the field, both in terms of specific initiatives to reduce pollution and of specific studies intended to help produce a better basis for decisions on future measures.

The government wishes to assess, in the light of the results of the many ongoing and planned studies, the need for new measures to achieve the objectives set out in the strategy. On this basis, I hope in 2009 to be able to further define and focus future efforts.

I wish you an interesting read.

Troels Lund Poulsen (V), Danish Minister for the Environment

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Vision and objectives

Vision

We must all be able to breathe outdoors without worrying about air pollution. This applies regardless of whether we live in rural areas or in towns and cities, or are out and about in the countryside.

The vision, therefore, is that there must be

clean air for all

The strategy is based on the objectives for Denmark's air quality and emissions that we have helped to adopt through our work within the EU, and which still represent a considerable challenge in respect of certain substances.

Objectives

The objective is as follows:

Air pollution shall be reduced such that:

- **all the ambient air quality limit values are met (see Table 1)**[1]
- **all the emission ceilings are met by 2010 (see Table 2)**
- **all the obligations under the Geneva Convention on Long-range Transboundary Air Pollution are met by 2015 (see Tables 2–4)**

Achieving the objective will be an important milestone in the longer-term work on continuing to reduce air pollution, not only in Denmark but also at EU and international level.

[1] For PM_{10} and NO_2 , recourse is had to the option of deferral until 2011 or 2015, as appropriate.

Danish action to date

Even back in the 1960s, air pollution was recognised as a public health problem in Denmark. In 1974, the Danish Environmental Protection Act and the corresponding Air Guidelines provided the authorities with effective instruments for reducing pollution from around 7 000 enterprises.

The environmental legislation has since been revised several times and supplemented by economic instruments such as taxes and voluntary schemes, for example eco-labels and eco-management. Significant progress was made with the regulation in 1991 of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) from power plants, the introduction of a tax on sulphur dioxide emissions in 1995, and the elimination of dioxin emissions from waste incineration plants via the requirement for advanced abatement equipment. With regard to traffic, the phasing out of lead in petrol in the 1980s and the introduction of catalytic converters in petrol cars in the 1990s led to substantial reductions in the transport sector's contribution to air pollution.

Air pollution is a cross-border phenomenon. Pollution can be transported by the wind over long distances, and the products that cause pollution are normally traded on free global markets. In recent years, therefore, Danish action on air pollution has mainly been oriented towards the EU and the development of pan-European rules for industrial enterprises, electricity and heat production, and the transport sector.

All in all, the efforts to reduce air pollution have been a great success. Since 1990, for example, emissions of NO_x have been reduced by approximately 33%, SO_2 by as much as approximately 86%, and lead by approximately 95% (see Figure 1).

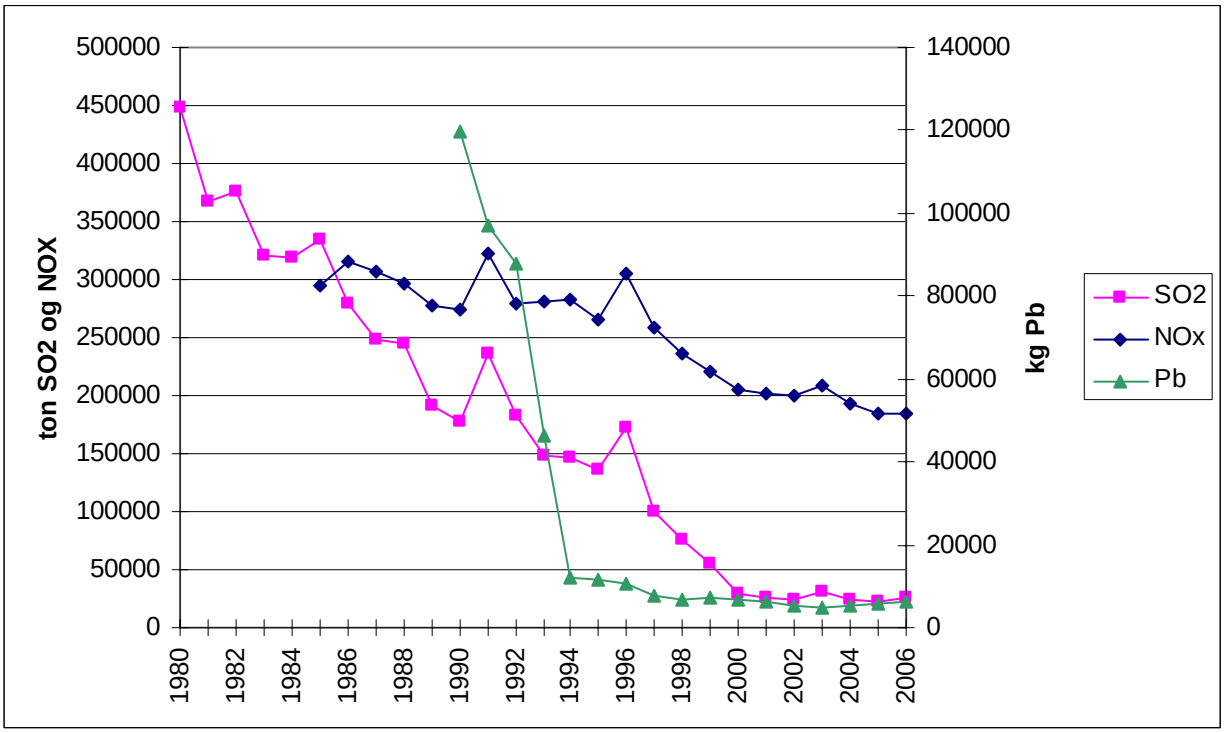

Figure 1. Trend in Danish emissions of SO_2, NO_x and lead (Pb). Source: Danish National Environmental Research Institute, 2008

The reduced emissions have also led to improvements in ambient air quality. In busy streets, for example Jagtvej in Copenhagen, there has been a substantial improvement in ambient air quality over the past 20 years or so (see Figure 2).

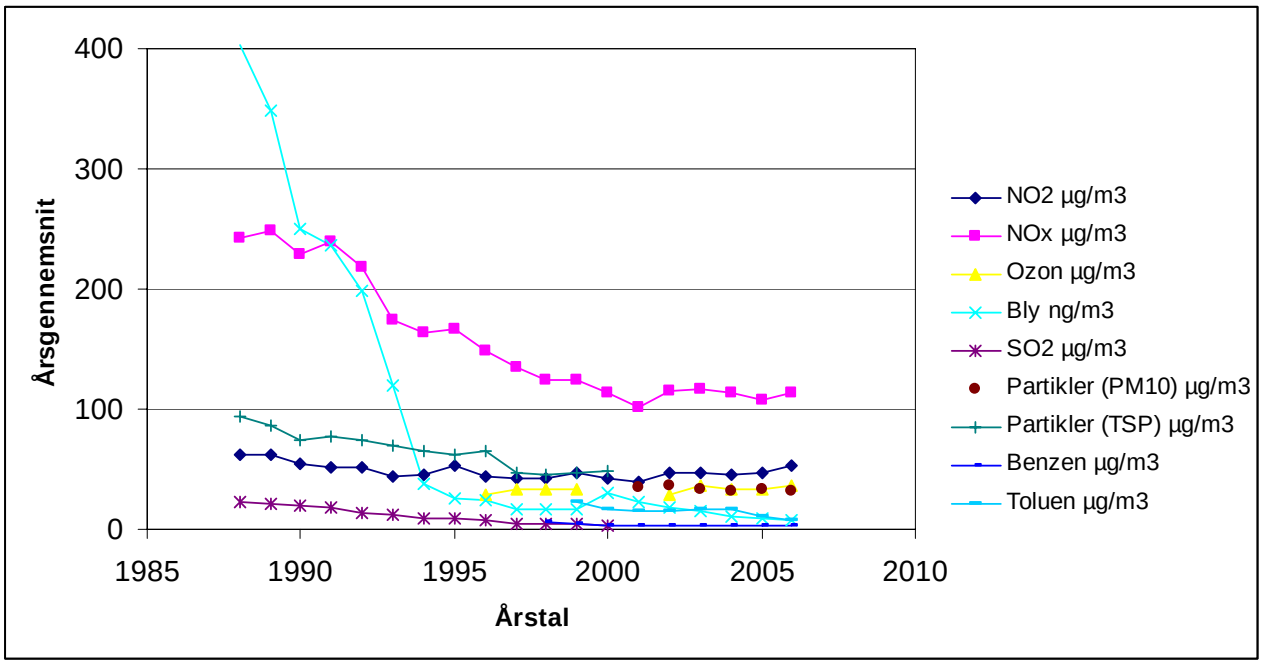

Figure 2. Trend in ambient air quality on Jagtvej in Copenhagen, averaged over one year. Source: Danish National Environmental Research Institute, 2008

The cleaner air efforts of recent decades have thus been a success story in many areas.

Challenges for the near future

Great progress has been made on air pollution in recent decades, yet this pollution still represents a challenge, particularly for public health. Together with a number of other European countries, Denmark must devote additional effort to certain substances, in order to meet its international commitments to reducing its overall contribution to regional air pollution and to improving ambient air quality in our towns and cities.

Environmental and health effects

The kind of air pollution with particular significance from a health point of view is particulate air pollution. Particulate pollution can cause cardiovascular disease, respiratory diseases, allergies and cancer.

A number of other substances, for example ozone (O_3) and nitrogen dioxide (NO_2), also give rise to health effects, but these effects are deemed far less serious than the effects of particulate pollution.

Particularly damaging to the environment are emissions of nitrogen oxides (NO_x = NO + NO_2) and ammonia (NH_3). These substances contribute in particular to overfertilisation and, among other things, account for 20–40% of the nutrients from man-made sources that enter Danish waters.

EU requirements

Through its work within the EU, Denmark has helped implement a number of ambitious European environmental standards in the field of air pollution. Key in this regard are the Ambient Air Quality Directives, which lay down limit values for a number of substances in ambient air and are intended to protect public health, and the Directive on National Emission Ceilings (NEC Directive), which lays down an upper limit for each country's total emissions of four selected substances and is intended to reduce the countries' contribution to regional air pollution.

Added to these are a number of other directives and regulations that impose, more or less specifically, various emission requirements on certain sectors, for example the Directive concerning integrated pollution prevention and control (IPPC Directive), and regulations laying down emission standards for vehicles.

Ambient air quality

The current and new health-related limit values and objectives for ambient air quality are laid down in four directives, and were transposed into Danish law in 2007.

Table 1 shows that Denmark is complying with most of the limit values, although an additional effort is still needed in order to achieve the objectives for particulate matter (PM_{10}) and nitrogen dioxide (NO_2).

Substance	Entry into force	Limit (L) Target value (T)	Max. conc. (2006)
Sulphur dioxide (SO_2), average hourly value	1 January 2005	350 µg/m^3, not to be exceeded more than 24 times per calendar year (L)	57 µg/m^3
Sulphur dioxide (SO_2), average daily value	1 January 2005	125 µg/m^3, not to be exceeded more than 3 times (L)	5 µg/m^3
Nitrogen dioxide (NO_2), average hourly value	1 January 2010 (2015)[2]	200 µg/m^3, not to be exceeded more than 18 times per calendar year (L)	159 µg/m^3
Nitrogen dioxide (NO_2), average annual value	1 January 2010 (2015)[2]	40 µg/m^3 (L)	53 µg/m^3
Particulate matter (PM_{10}), average daily value Average annual value	1 January 2005 (2011)[2]	50 µg/m^3, not to be exceeded more than 35 times per calendar year (L) 40 µg/m^3 (L)	64 µg/m^3 E.g. exceeded 80 times in Odense 41 µg/m^3
Particulate matter ($PM_{2.5}$), average annual value	1 January 2015	25 µg/m^3 (L)	15 µg/m^3
Lead (Pb), average annual value	1 January 2005	500 ng/m^3 (L)	9 ng/m^3
Benzene, average annual value	1 January 2010 (2015)[2]	5 µg/m^3 (L)	2.3 µg/m^3
Carbon monoxide (CO), maximum daily 8 hr average	1 January 2005	10 mg/m^3 (L)	2.7 mg/m^3
Ozone (O_3), maximum daily 8 hr average value	2010	120 µg/m^3, not to be exceeded on more than 25 days per year averaged over 3 years (T)	113 µg/m^3
Ozone (O_3), maximum daily 8 hr average value within one year	Long-term objective with 2020 as the reference year	120 µg/m^3 (T)	163 µg/m^3
Arsenic (As), average annual value	1 January 2013	6 ng/m^3 (T)	0.9 ng/m^3
Cadmium (Cd), average annual value	1 January 2013	5 ng/m^3 (T)	< 2.4 ng/m^3
Nickel (Ni), average annual value	1 January 2013	20 ng/m^3 (T)	5 ng/m^3
Tar substances (PAH – marker: benzo(a)pyrene), average annual value	1 January 2013	1 ng/m^3	0.2 ng/m^3 [3]

[2] Option of deferral, see Directive

Table 1. Current limit values and objectives, date of entry into force and maximum concentration measured in 2006 as part of the nationwide measuring programme (measurements taken in Copenhagen, Aarhus, Odense and Aalborg)

As part of the implementation of the EU 'Clean Air for Europe' (CAFE) strategy, the Council and the European Parliament reached an agreement to also set a new limit value for fine particles ($PM_{2.5}$) in ambient air. Together with ultra-fine particles ($PM_{0.1}$), fine particles are deemed to bear the main responsibility for the adverse health effects caused by particulate matter.

Emissions

As Table 2 shows, Denmark is projected to remain below the emission ceiling for SO_2 by a wide margin, with Danish emissions being among the lowest in the EU. Nor will the ceiling for ammonia (NH_3) pose any problems for Denmark, as our country is one of the EU Member States that has done the most to reduce this kind of pollution. However, complying with the ceiling for nitrogen oxides (NO_x) by 2010 will require an additional effort. New analyses of emissions of volatile hydrocarbons (VOC) will show whether further measures are needed for these, too.

Substance	Emission ceiling (tonnes)	Projected emissions (2010)	Projected difference
Sulphur dioxide (SO_2)	55 000	19 900	- 35 100
Nitrogen oxides (NO_x)	127 000	130 700[4]	+ 3 700
Volatile hydrocarbons (VOC)	85 000	88 000	+ 3 000
Ammonia (NH_3)	69 000	65 500	- 3 500

Table 2. Emission ceilings for 2010, projected emissions in 2010 and projected difference between the two

During 2008, the European Commission is expected to present a proposal for stricter emission ceilings for these four substances, to which will now be added PM_{10} particulate matter. The new emission ceilings are to apply from 2020 onwards, and are expected to have a tremendous impact on EU ambient air quality in the future.

International requirements

All the international obligations relating to ambient air quality that are not contained in the United Nations Framework Convention on Climate Change or the EU provisions are laid down in the protocols to the Geneva Convention on Long-range Transboundary Air Pollution (LRTAP).

The following protocols contain current obligations:

The primary obligation under the **Protocol on Heavy Metals** is that Denmark reduce its emissions of lead, cadmium and mercury to 1990 levels. This protocol also obliges Denmark to apply best available

[3] Estimate based on available measurements

[4] Takes account of the recently adopted NO_x tax

techniques in the broad sense when reducing its emissions of these three substances, and sets emission limit values for a number of activities. Denmark [has] no trouble complying with the provisions of the protocol (see Table 3).

Substance	1990 emissions (tonnes)	2006 emissions (tonnes)	Actual change
Lead (Pb)	119.8	6.2	- 113.6
Cadmium (Cd)	1.1	0.7	- 0.4
Mercury (Hg)	3.2	1.3	- 1.9

Table 3. Trend in Denmark's emissions of selected heavy metals from 1990 to 2006

The **Protocol on Persistent Organic Pollutants (POPs)** contains an obligation to eliminate the production and use of 12 POPs, which have been banned in Denmark since 1995. The use of three substances is to be significantly reduced, an obligation that Denmark has also met. Finally, emissions of three substances (dioxins, tar substances (PAH) and hexachlorobenzene (HCB)) must not exceed 1990 levels. No penalties [or] deadline have been laid down with regard to this obligation.

Mainly owing to the increasing use of wood for domestic heating, Denmark's total emissions of PAH are currently around 14.7 tonnes, which clearly exceeds the limit. Therefore, Denmark must reduce its emissions as rapidly as possible to under 6.6 tonnes, which corresponds to 1990 levels. No formal deadline has been set for this, however. Emissions of HCB have not been calculated, as they are presumed to be negligible. Denmark has no trouble meeting its obligations in respect of the other POPs (see Table 4).

Substance	1990 emissions	2006 emissions	Actual change
Dioxins	66 g	26 g	- 40 g
Tar substances (PAH)	6.6 tonnes	14.7 tonnes	+ 8.1 tonnes
Hexachlorobenzene (HCB)	Negligible		
Other POPs	Details not included here		

Table 4. Trend in Denmark's emissions of POPs from 1990 to 2006

Talks have been started that will add seven new substances to the Protocol on Persistent Organic Pollutants.

The **Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone** mainly commits Denmark to emission ceilings identical to those of the NEC Directive (see Table 2). In addition, this protocol contains a number of annexes listing emission limit values that are, by and large, a carbon copy of the EU directives in force at the time.

What are the sources of air pollution?

Denmark faces a number of challenges relating to ambient air quality, and in particular to compliance with limit values for particulate matter (PM_{10}) and nitrogen dioxide (NO_2) in ambient air, and to the reduction of total emissions of nitrogen oxides (NO_x), tar substances (PAH) and possibly also volatile hydrocarbons (VOC). In the interests of a targeted fight against air pollution, it is important to know where pollution originates.

Air pollution is the complicated product of emissions into the atmosphere, atmospheric dispersion, and chemical and physical transformation in the atmosphere. Low sources (for example traffic and local domestic heating) can cause high local air pollution, and therefore such sources in urban areas can result in relatively heavy exposure of the population.

The pollution from high point sources (for example power station chimneys) undergoes considerable dilution before it reaches ground level, and thus does not cause any substantial exposure among the Danish population, but it does contribute to general background pollution in Europe. Similarly, Denmark is substantially affected by pollution from the rest of Europe, including from ships.

In addition, there are a number of natural sources of air pollution, for example VOC from vegetation, soil dust, sea salt and forest fires. However, these sources are largely outside human control and hence are not included in this action plan.

Particulate matter and NO_2 in the urban atmosphere

Air in the urban background – that is, in urban areas more than 50 metres or so from a busy street – is normally taken as the best measure of population exposure to air pollution. Table 5 gives an approximate breakdown of the contributions of Danish and foreign sources with regard to air in the countryside, in towns/cities (urban background) and along busy streets, respectively.

Substance	In the countryside	Urban background	Along streets
Particulate matter (PM_{10})	approx. 18 µg/m^3	20–22 µg/m^3	25–45 µg/m^3
Of which from DK	20–30%	30–50%	55–75%
Of which from abroad	70–80%	50–70%	25–45%
Nitrogen dioxide (NO_2)	approx. 10 µg/m^3	approx. 20 µg/m^3	approx. 50 µg/m^3
Of which from DK	10–30%	55–65%	82–86%
Of which from abroad, in %	70–90%	35–45%	14–18%

Table 5. Approximate breakdown of Danish and foreign sources with regard to air in the countryside, in towns/cities (urban background) and along busy streets

It can be seen that foreign sources are responsible for a very large proportion of particulate pollution, even along busy streets in towns and cities. On the other hand, up to 86% of nitrogen dioxide (NO_2) pollution originates from national sources.

It can also be seen that the highest values occur along the busy streets. In addition, it should be pointed out that the contribution to particulate matter along busy streets consists in large part of whipped-up dust, and in lesser part of particulate exhaust emissions. On the other hand, a large number of studies point out that it is the particulate matter from exhaust emissions that causes health effects.

A general problem in relation to both particulate matter and NO_2 is the growing proportion of diesel cars, which is predicted to increase fivefold in the period 1995–2020.

Major sources of NO_x, VOC and PAH emissions

Each year, the National Environmental Research Institute calculates Denmark's total emissions into the atmosphere of a wide range of substances. Its report shows the contribution by individual sectors to total emissions.

Source	Nitrogen oxides (NO_x) (%)	Volatile hydrocarbons (VOC) (%)	Tar substances (PAH) (%)
Energy production	**28**	3	0.4
Manufacturing and construction	13	2	1.2
Transport	**42**	**23**	2
Commerce and services	-	1	4.1
Commercial and institutional plants	0.7	-	-
Households (mainly wood burning)	3.3	**23**	**87.3**
Agriculture, forestry, fisheries and military	12	5	4.9
Fugitive emissions from fuels	1.2	13	-
Industrial processes	-	1	-
Solvents	-	**29**	-

Table 6. Danish NO_x, VOC and PAH emissions in 2006. Source: Danish National Environmental Research Institute, 2008

Table 6 shows that NO_x emissions mainly originate from the transport sector and energy production. The main sources of VOC emissions are solvents, the transport sector and wood burning by households. PAH emissions originate almost exclusively from wood burning by households.

Focusing of efforts

Described below is the government's action in three focus areas in which the above analysis justifies a special effort to reduce pollution:

No 1. Cleaner air in towns and cities
No 2. Cleaner wood burning
No 3. Cleaner shipping

A summary of implemented, ongoing and planned measures is given below for each focus area.

In order to make the right choices regarding targeted, cost-effective action, it is important that a sufficiently technical, economical decision-making basis is also provided for the implementation of new measures to achieve the objectives of the action plan. Therefore, a summary of ongoing and planned analysis projects is also given for each of the above three focus areas.

In addition, a further two cross-cutting focus areas are identified that are to provide the basis for the longer-term action on air pollution, including in the period after 2015:

No 4. Eco-efficient technology
No 5. Knowledge building

Focus area No 1: Cleaner air in towns and cities

Diesel vehicles are the main direct source of air pollution in our towns and cities. Diesel cars have become increasingly common in recent years on account of their superior fuel efficiency, and the trend is being reinforced by our promotion of fuel-efficient vehicles through national tax legislation and within the framework of the EU as part of our efforts to reduce CO_2 emissions.

Diesel particulates are particularly harmful to health, and so an important objective is the promotion of particulate filters on diesel vehicles. Diesel also produces higher NO_x emissions, and the increasing proportion of diesel vehicles also means that NO_2 pollution in the urban atmosphere is not falling as was originally predicted.

The EU is also focusing on urban air pollution, and particulate filters will be compulsory on new diesel cars in the coming year.

Danish enterprises have a strong position on the markets for particulate filters and catalytic converters for vehicles.

Implemented measures

- Sulphur-free petrol and diesel
- Subsidies for particulate filters on lorries and buses
- Reduced-rate vehicle registration tax for new diesel passenger cars and light commercial vehicles
- Possibility of environmental zones in cities, in which older lorries and buses are required to have particulate filters
- EU standards for diesel passenger cars and light commercial vehicles that will make filters compulsory on new vehicles from 2011 (passenger cars) and 2012 (light commercial vehicles), respectively

Ongoing and planned measures

- Instrument catalogue for measures to reduce NO_2 emissions
- Financial support for the development, testing and/or demonstration of new technologies for reducing vehicle emissions of NO_x, VOC and particulate matter
- Tax exemption for hydrogen vehicles
- Extension of tax exemption for electric vehicles until 2012
- Trial scheme for electric vehicles
- Denmark is working within the EU to ensure that new EU standards for heavy-duty vehicles enter into force earlier than 2015, as proposed by the Commission. In practice, the new standards will make particulate filters and Selective Catalytic Reduction (SCR) catalytic converters compulsory on new vehicles, which will also reduce ultra-fine particulate matter
- Analysis of possibilities for developing environmental standards for vehicles in environmental zones

In addition, there are the measures which will emerge from the government's ongoing work on following up the recommendations of the Danish Infrastructure Commission, which have the potential, directly or

indirectly, to have a positive impact on ambient air quality in our towns and cities.

Focus area No 2: Cleaner wood burning

Wood-burning stoves and boilers have many advantages, particularly the fact that firewood constitutes CO_2-neutral renewable energy. However, wood burning in small firing installations without any means of abatement pollutes the atmosphere with a number of substances harmful to health, including particulate matter, PAH, VOC and dioxins. With fuel consumption increasing, reducing this pollution is an ever growing challenge. Therefore, our work on reducing air pollution from wood-burning stoves and boilers needs to be seen together with our efforts to reduce Danish CO_2 emissions.

Pollution from wood-burning stoves and boilers is determined by complicated interplay between fuel, firing habits, firing installation, the chimney and its location relative to the roof, type of terrain, plant growth and distance from neighbours. Added to this is the important role played by chimney sweeps and municipal authorities in terms of control and maintenance, and also inspections and processing of cases of complaints about nuisance caused by wood smoke.

Therefore, the efforts to reduce pollution from wood-burning stoves and boilers should involve a number of different instruments. With approximately 600 000 wood-burning stoves and boilers in Denmark, there is a need to focus efforts so as to target the places where the problems with wood smoke are greatest (wood-smoke hot spots). Studies by the National Environmental Research Institute show that a relatively small number of wood-burning stoves and boilers account for a disproportionately large amount of the pollution.

Danish enterprises have a strong position on the markets for environmentally friendly wood-burning stoves and boilers.

Implemented measures

- Nationwide information campaigns concerning proper firing of wood-burning stoves and boilers
- Specification of the scope for action by municipalities in cases of substantial wood-smoke pollution
- Option for municipalities to lay down stricter requirements for wood-burning stoves and boilers in defined residential areas
- Emission requirements for wood-burning stoves and boilers

Ongoing and planned measures

- Financial support for the development and testing of cleaner wood-burning technologies
- Innovation partnerships for environmentally friendly wood-burning technologies
- Testing of filters and similar technologies for reducing pollution from wood burning
- Modernisation of the totality of boilers in Denmark (scrapping scheme for boilers)
- Identification of areas particularly affected by wood smoke (wood-smoke hot spots)

- Active efforts to extend Danish emission requirements for wood-burning stoves to the rest of the EU
- Active efforts to tighten the European standard for boilers
- Analysis of possibilities for further measures in wood-smoke hot spots

Focus area No 3: Cleaner shipping

Overall pollution from shipping has seen a general increase in recent years. This is due to both the growth in shipping and the fact that the rules for air pollution from ships are not as strict as those for land-based sources. Without the international rules in the field, we would have seen a far greater increase in the air pollution from international shipping.

In 2000, shipping-related NO_x and SO_x emissions in European waters corresponded to approximately 30% of emissions from land-based sources in the EU-25. In 2005, the European Commission estimated that, if the rules for air pollution from ships were not tightened further, the contribution by shipping to NO_x and SO_x emissions would exceed emissions from land-based sources by 2020.

The international regulation of air pollution from ships is primarily carried out by the International Maritime Organization (IMO) of the United Nations. The first rules for air pollution from ships entered into force in 2005. These rules lay down requirements for emissions of NO_x and SO_x from ship engines. The EU has laid down requirements for ships' SO_x emissions that are very similar to those laid down by the IMO. However, the requirements are far less strict than those applying on land to lorries and power plants, for example. No rules have been laid down specifically for particulate emissions from ships. Particulate pollution from ships is closely linked with emissions of SO_x and NO_x, and therefore particulate pollution will decrease concurrently with a tightening of the rules for emissions of these substances.

Special national rules for air pollution from ships can easily result in ships engaged in international voyages re-flagging to countries with less restrictive legislation. It is good, then, that the IMO has just reached agreement on a set of new rules for emissions of NO_x, SO_x and particulate matter from ships, including rules for emissions from ships in service and ships sailing in particular coastal waters. These are ambitious, future-oriented rules, which will lead to a substantial reduction in air pollution from shipping.

Denmark's efforts to meet its obligations under the EU Directive on national emission ceilings need to include action specifically targeting ships that are registered in Denmark and hence are included in Danish emission inventories.

Shipping is an international industry in which Denmark plays an important role. Danish trade and industry has a strong position in the shipping sector, with Danish manufacturers commanding a sizeable share of the world market for ship engines and catalytic converters for NO_x abatement.

Implemented measures

- Current IMO rules on NO_x and SO_x emissions transposed into Danish law
- In IMO negotiations, Denmark has pushed for the new rules to be as strict as possible and has particularly worked to ensure that the rules also cover older ships in service

Ongoing and planned measures

- Stricter, more precise rules and practice with regard to enforcement in the area
- Research into possibilities for reducing NO_x emissions from domestic shipping traffic
- Continued work within the IMO to finalise NO_x rules for ships in service
- Financial support for the development, testing and/or demonstration of technologies for reducing emissions of NO_x and particulate matter from ships, particularly domestic ferries
- Identification of the contribution to air pollution in Denmark made by shipping

Focus area No 4: Eco-efficient technology

Eco-efficient technology is essential to enable us to continue reducing the burden on the environment without curbing economic growth.

Particularly important in terms of the use of eco-efficient technology in enterprises is the EU's certification scheme on integrated pollution prevention and control (IPPC Directive). To comply with the IPPC Directive, Danish enterprises must apply best available techniques (BAT), which are laid down, *inter alia,* in 'BREF documents' (Best Available Technique Reference Documents), which are made binding by the Commission's new draft IPPC Directive. At present, BREF documents have been published for 32 of the 33 sectors covered. A screening of selected BREF documents has revealed significant potential for reducing air pollution by better incorporating BAT into the rules for Danish enterprises.

In July 2007, the government presented an action plan for promoting eco-efficient technology. The action plan contains a number of measures for developing and using eco-efficient technology, including partnerships, export promotion, research, consultancy, information, knowledge building and promotion of eco-efficient technology in the EU.

Denmark has a strong global competitive position in the area, with a number of world-leading enterprises, for example in the fields of fuel cleaning, environmentally friendly ship engines and flue-gas cleaning for power plants, industrial enterprises and waste incineration plants. In addition, Denmark has competence in the field of control of combustion processes and measuring and modelling of air pollution. Finally, Danish enterprises are at the cutting edge in the fields of particulate filters, catalytic converters for vehicles and environmentally friendly wood-burning stoves and boilers.

Therefore, better use and continued development of eco-efficient technology can reinforce the competitiveness and market opportunities of Danish enterprises.

Implemented measures

- Identification of the strengths of Danish enterprises in the field of air pollution
- Analysis of selected BREF documents in specific fields with a tangible impact on Danish enterprises that have special potential for reducing air pollution

Ongoing and planned measures

- As part of the government's action plan for promoting eco-efficient technology, a total of DKK 26 million has been earmarked for the 2007–2009 period, for developing, testing and evaluating eco-efficient technology to promote a healthy environment. Approximately DKK 7 million of this can be spent on technologies with the potential to reduce air pollution (see focus areas Nos 1–4 for further information)
- As part of the implementation of the Globalisation Fund, DKK 144 million has been earmarked for the 2007–2009 period, for strategic research into environmental technology, including for the field of air pollution

- A tax of DKK 5 per kilogram on NO_x emissions from stationary firing installations and enterprises
- Analysis of the future EU rules on air pollution with a view to promoting environmental technology
- Analysis of selected BREF documents with a view to better utilisation of BAT in Danish certification legislation, for example through standard conditions and/or incorporation of general requirements into the Danish Air Guidelines

Focus area No 5: Knowledge building

A prerequisite for cost-effective action to protect public health and the environment is knowledge about emissions to air from various sources, about transport, possible transformation in the atmosphere, and exposure of the population and the resulting health implications.

In background areas in Copenhagen, for example, it is now possible to account for approximately two thirds of the pollution by particulate matter ($PM_{2.5}$) by a contribution from natural sources, direct contributions from traffic, etc., and particles formed in the atmosphere. It is not possible at present, however, to account for the sources constituting the remaining third, and this share is expected to become even larger in the future.

Implemented measures

- Improved calculation models, particularly with regard to the emission, dispersion and transport of pollution
- Since 2003, a wide range of review projects has been carried out concerning ambient air quality, with a view to reinforcing the knowledge base on the connection between the environment and health

Ongoing and planned measures

- Ambient air measuring programmes and emission measurements
- Review of and research into health effects caused by particulate pollution
- Review of the existing projections of VOC emissions, with a view to seeking ways to meet the emission ceiling for VOC
- Review of the sources and levels of the burden on the population from ultra-fine particulate matter

Glossary

Volatile hydrocarbons (VOC): volatile hydrocarbons (Volatile Organic Compounds, VOC) are organic compounds that have a great impact on the environmental and health effects of air pollution. They can contribute to the formation of photochemical air pollution, cause odour nuisance or simply be toxic in themselves. A distinction is generally made between methane (CH_4) and the other hydrocarbons. Methane is a greenhouse gas, but plays only a minor role as a direct pollutant, whereas heavy volatile hydrocarbons can have health impacts either as particulate matter or as adsorb on the surface of particles.

Nitrogen dioxide (NO_2) and nitrogen monoxide (NO): NO_2 and NO are the most common nitrogen oxides (NO_x). NO_x is the generic name covering NO_2 and NO plus a number of other nitrogen compounds. NO is not harmful to health in the concentrations in which it is found, but on contact with ozone it reacts relatively quickly to form NO_2. Therefore, the incidence of NO_2 will often be determined by the quantity of ozone available. NO_2 is harmful to human health. The main source of nitrogen oxide pollution is combustion, as fuels contain nitrogen compounds. Even atmospheric nitrogen oxidises, however – first to NO and then, in the atmosphere, to NO_2.

Particulate matter (PM_{10}, $PM_{2.5}$ and $PM_{0.1}$): particulate air pollution is the result of emissions (released into the atmosphere by diesel engines and wood-burning stoves, for example), atmospheric dispersion and chemical and physical transformations. Finally, there are natural sources of atmospheric particulate matter, for example soil dust, sea salt and forest fires. The commonly used terms are PM_{10}, which covers particles up to 10 µm (1 µm = 1/1000 mm) in diameter, $PM_{2.5}$ (particles up to 2.5 µm) and $PM_{0.1}$ (particles under 0.1 µm). The fine particulate matter (under 2.5 µm) can remain suspended for several weeks and thus be transported over several thousand kilometres. Owing to physical and chemical processes in the atmosphere, this particulate matter contains a high proportion of ammonium sulphate and ammonium nitrate. Sulphates and nitrates chiefly originate from combustion processes (emitted in the form of SO_2 and NO_x), whilst ammonium mainly originates from ammonia emissions from agriculture. The reduced sulphur content in fuels in Europe and the introduction of desulphurisation in power plants has led to a marked decrease in the sulphur content of particulate matter in recent years. Coarse airborne particulate matter is typically formed by various mechanical processes, for example soil and road dust whipped up by the wind, gritting and salting of slippery roads, sea spray (which dries into salt particles), volcanoes, vegetation (pollen), tyre and road-surface wear, road traffic-related turbulence, construction and industrial activities. This kind of particulate matter has a short lifespan, as its weight means that it does not remain suspended for very long.

Tar substances (PAH): the term PAH (polycyclic aromatic hydrocarbons) covers a group of more than 100 substances. These substances were first discovered as components of coal tar and soot, hence the name ‘tar substances’. The chief source of PAH air pollution is smoke from domestic heating, especially from wood burning. In addition, there are emissions from traffic, cogeneration plants, waste incineration plants and a wide range of

industrial processes. Oil spills from ships and oil rigs can also be a source of PAH pollution. Finally, tobacco smoke can be a considerable source of PAH, particularly indoors. PAH and a wide range of substances derived from it attach themselves to particles in the air. They can contaminate crops and soil as they descend from the atmosphere.