Proposal for a Climate Strategy for Denmark

Danish Government
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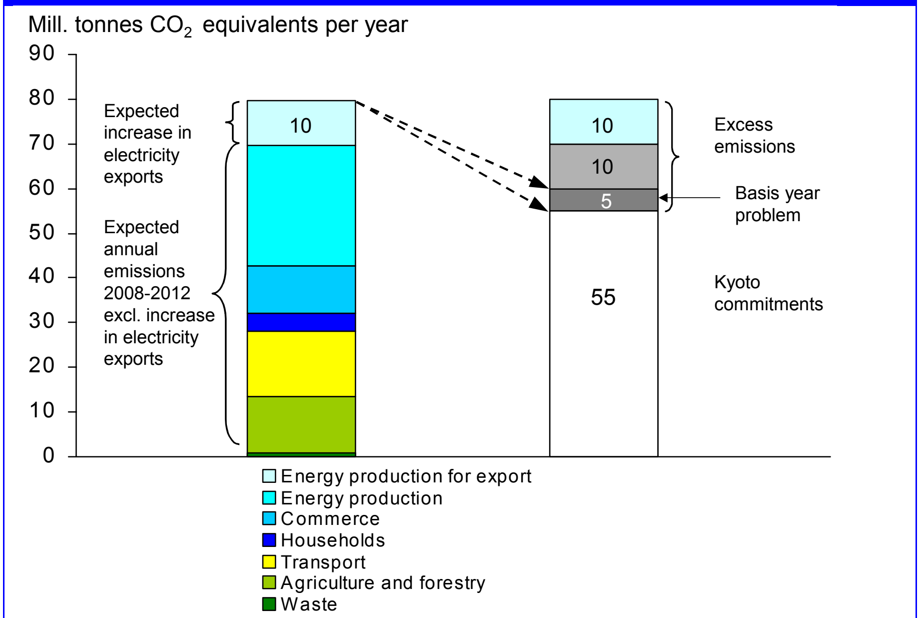
Summary

► As a consequence of the 1997 Kyoto Protocol and the subsequent 1998 EU Burden Sharing Agreement, Denmark is committed to reducing its average annual greenhouse gas emissions in the period 2008-2012 by 21 per cent in relation to the basis year, 1990.

► Danish greenhouse gas emissions have only decreased slightly since 1990, and substantial efforts are still required. In relation to expected emissions in 2008-2012, if *no* further initiatives are taken, excess emissions in relation to the reduction commitments are expected to be 20-25 million tonnes CO_2 equivalents per year. This corresponds to 25-30 per cent of total Danish greenhouse gas emissions.

Excess emissions in relation to Denmark's reduction commitments

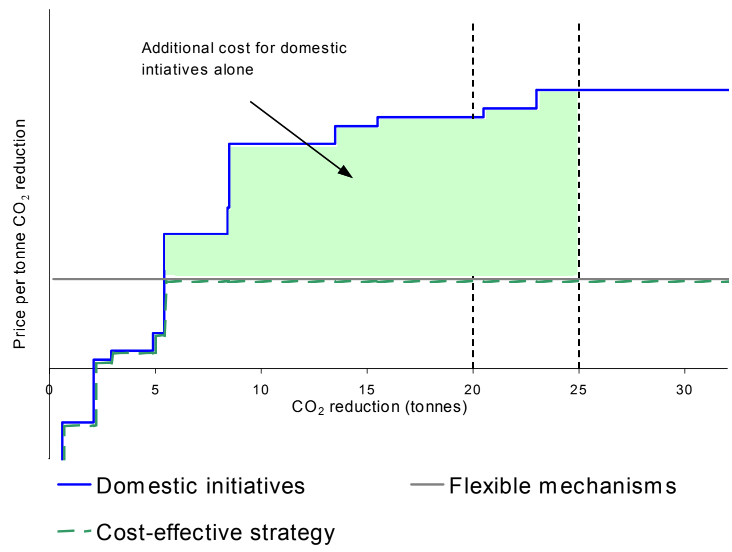


► Denmark's reduction commitments are extensive. This is primarily due to the fact that Denmark has accepted very ambitious reduction commitments in connection with establishing burden sharing among the individual EU Member States. In comparison, the total EU reduction commitments amount to 8 per cent.

► Flexible mechanisms, i.e. trading in the so-called credits from CO_2 reduction projects in developing countries and in Central and Eastern Europe as well as trading in CO_2 quotas, may contribute to fulfilling Denmark's reduction commitments. This reflects the fact that greenhouse gas emissions are a global problem that must be solved by ensuring the most cost-effective reduction at global level. Furthermore, flexible mechanisms can contribute to developing the countries in question through the transfer of know-how and capital.

► The costs for society of eliminating excess emissions will be between DKK 1-2 billion (EUR 135-269 million) and DKK 4-5 billion (EUR 538-673 million) *per year* in the five-year period 2008-2012 – dependent upon the choice of measures. The most expensive initiative would be using domestic measures in the form of extending the use of renewable energy. The most cost-effective initiative would be significant utilisation of flexible mechanisms, the price of which would be unlikely to exceed DKK 100 (EUR 13.46) per tonne CO_2, with a price level of DKK 40-60 (EUR 5.38-8.07) per tonne CO_2 being the most likely.

Reduction costs



► Regardless of the size of the burden of these reductions and how the financial burden is shared, ultimately Danish citizens will pay for the total efforts. Therefore, the way we deal with this challenge is crucial. An overall climate strategy should be based on cost-effective initiatives.

1. The Kyoto Protocol

In December 1997, an agreement was made in the Japanese city, Kyoto, according to which industrialised countries committed to fixed reduction targets for greenhouse gas emissions – the *Kyoto Protocol*. In total, the industrialised countries must reduce their average annual greenhouse gas emissions in the first commitment period under the Kyoto Protocol, the five-year period 2008-2012, by 5 per cent in relation to emissions in the basis year, 1990. However, the US has chosen not to ratify the agreement.

The distribution of reduction targets among the individual countries was laid down in the Kyoto Protocol. Internally in the EU, however, this was done in the subsequent *Burden Sharing Agreement* in 1998. As a consequence of the EU Burden Sharing Agreement, Denmark is committed to reducing average annual greenhouse gas emissions by 21 per cent in the period 2008-2012 compared to the basis year, 1990. Thus, Denmark has accepted substantial reduction commitments in relation to most other industrialised countries, see box 2. In comparison, the total EU reduction commitments amount to 8 per cent.

Box 1. The greenhouse effect– causes and consequences

The climate problem is partly due to the fact that, as a consequence of human activities, greenhouse gases are being emitted, and this leads to an increase in the total greenhouse gas concentration in the atmosphere. Greenhouse gases include particularly carbon dioxide, methane, nitrous oxide, and a number of industrial gases.

The UN Intergovernmental Panel on Climate Change (IPCC) has determined that the global mean temperature has gone up by 0.6 degrees Celsius in the course of the 20th century. Part of this increase may be due to natural effects such as volcanoes and changes in solar activity, but the main part of the increase in the last 50 years is thought to be created by humans.

The effects of a temperature increase will be both positive and negative – with variations from area to area – but overall, negative effects are expected to be dominant for the world as a whole. The negative consequences of rises in temperature and sea water levels and more unstable weather conditions are primarily expected to affect the least developed areas of the world. The developing countries are most vulnerable to climate changes such as drought, floods, and diseases like malaria. This must also be seen in connection with the fact that developing countries generally are more economically dependent on the agricultural sector; the sector most affected by climate change.

Box 2. The Kyoto Protocol and the reduction commitments

The Kyoto Protocol lays down fixed reduction commitments for the industrialised countries. So far, the developing countries have no reduction commitments. The commitments concern the average reductions that the contracting countries are committed to achieving in 2008-2012, compared to the basis year of the Protocol, 1990 (alternatively 1995 for industrial gases). The reduction commitments include the greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the industrial gases HFC, PFC, and SF_6. The remaining five greenhouse gases are converted into CO_2 equivalents.

The EU accepted the largest reduction commitments in the Kyoto Protocol, namely 8 per cent. It is worth mentioning that Japan and Canada accepted a commitment of

6 per cent, Russia and New Zealand 0 per cent, while for example Norway and Australia were allowed to increase emissions by 1 per cent and 8 per cent respectively. The US accepted a reduction commitment of 7 per cent, but it is not expected to ratify the Protocol.

The EU Burden Sharing Agreement from 1998 lays down the distribution of the total EU target of 8 per cent between the Member States. Luxembourg accepted the largest commitment, 28 per cent. Denmark and Germany accepted the second-largest commitment, 21 per cent. With regard to Luxembourg and Germany, the commitments should be seen in connection with the ongoing closure of obsolete heavy industry. It should be mentioned that the Netherlands accepted reduction commitments of 6 per cent, France 0 per cent, and that Sweden was allowed to increase emissions by 4 per cent.

If the targets of the Kyoto Protocol are to be met, thorough modernisation of, among other things, global energy production is required. This will require huge investment. With their high energy consumption and intensive agriculture, the industrialised countries have so far accounted for the majority of greenhouse gas emissions. This is the reason that, via the Kyoto Protocol, these countries have committed themselves to leading the way and paying for the solution.

However, the EU Member States are already in front with efficient energy use and other environmental improvements. Further initiatives to reduce emissions will therefore be relatively costly and have limited effect. On the other hand, energy efficiency is low in Eastern Europe and Russia as well as in a number of developing countries and therefore, there are good possibilities for carrying out cost-effective reduction measures in these countries.

It is irrelevant for the total concentration of greenhouse gases in the atmosphere, *where* the emissions take place. A reduction initiative that leads to a reduction of 1 tonne CO_2 emissions in China has the same effect on the total CO_2 concentration as a similar reduction initiative in a Western European country. This is the reason that the so-called *flexible mechanisms* were developed in connection with the reduction agreement in the Kyoto Protocol.

The reduction commitments that the industrialised countries accepted must be seen in connection with the opportunity to utilise these flexible mechanisms. Thus, the flexible mechanisms of the Kyoto Protocol allow the industrialised countries to finance the implementation of reduction initiatives in developing countries and in Central and Eastern Europe. In these countries, pollution abatement is less developed and modernisation in the energy sectors of these countries, for instance, will have great effects on CO_2 emissions.

The flexible mechanisms constitute an alternative and a supplement to implementing domestic reduction initiatives. There are three types:

1. trade in emission quotas between countries,
2. implementation of projects to reduce greenhouse gas emissions in Central and Eastern Europe – *Joint Implementation* (JI), and
3. implementation of projects to reduce greenhouse gas emissions in developing countries – *Clean Development Mechanism* (CDM).

Box 3. *The Joint Implementation* project "Sawdust 2000"

The Danish Environment Protection Agency is currently finalising the preparations for a JI project in Rumania. The project entails the conversion of five district heating systems from oil and gas combustion to incineration of wood waste from the local wood industry by establishing new boiler houses, district heating networks and restoration of installations.

This project will provide heat supply for approximately 12,000 citizens and is expected to lead to annual greenhouse gas reductions of up to approximately 53,000 tonnes CO_2 equivalents.

Rumania has built a flourishing forestry industry, but this has led to significant environmental problems with wood waste being deposited in forests and rivers. In comparison with fossil fuels, the utilisation of wood waste for heating is an extremely cost-effective solution in Rumania, since so far, the waste can be collected at no cost. The project thus entails both economic and environmental benefits for the local areas in question.

The objectives and effects of flexible mechanisms are that the globally established reduction initiatives are implemented where the greatest reduction per euro spent can be achieved. This means overall achieving the largest possible greenhouse gas reduction for the money spent.

Extensive use of flexible mechanisms will lead to significant transfers of capital and know-how from Western industrialised countries to developing countries and to countries in Central and Eastern Europe. At the same time, these countries will enjoy all the other environmental benefits (apart from the reduction CO_2 and other greenhouse gases), which are related to cleaner and more modern energy production – less emissions of NO_x, SO_2, and particles.

The Danish government has earmarked DKK 130 million (approx. EUR 17.5 million) in the 2003 Finance Act for the establishment of *Joint Implementation* projects in Central and Eastern Europe. See box 3 for an example of such a project. In addition, the preparations for possible future utilisation of flexible mechanisms (CDM) will form part of the implementation of environmental initiatives in developing countries for 2003.

Box 4. Flexible mechanisms

International trade in emission quotas means that countries with reduction commitments are allowed to trade emission permits. Thus, countries with high domestic reduction costs (and large reduction commitments) can buy quotas from countries with lower domestic reduction costs (and low reduction commitments). The Western European countries, Japan and Canada are expected to be the largest net buyers of quotas. The largest net supplier of quotas is expected to be Russia.

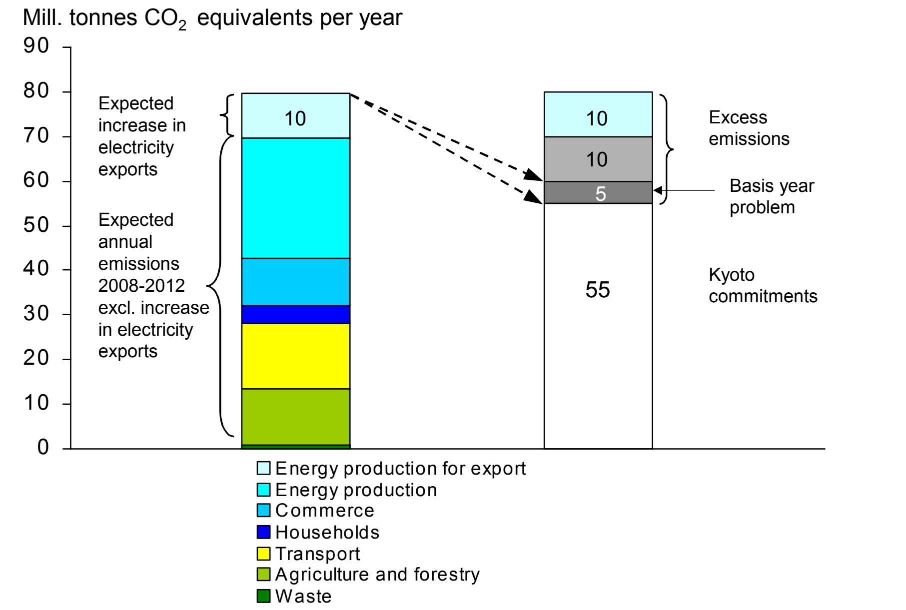
Joint Implementation (JI) and *Clean Development Mechanism* (CDM) mean that a country can finance *projects* abroad and use the emissions reductions (called credits) created to fulfil its own commitments. JI projects are established in host countries that have reduction commitments (typically in Eastern Europe), and credits may be achieved from 2008. CDM projects are established in host countries that do not have reduction commitments (typically in developing countries), and credits may be achieved from 2000. Typical projects are expected to be energy supply projects and methane projects (emissions from landfills, etc.) and, in the longer term, afforestation projects.

It is expected that an integrated market for quotas and credits will arise. The average price in this market is not expected to exceed DKK 100 (EUR 13.46) per tonne CO_2 equivalents in 2008-2012 – the most likely price level lying between DKK 40-60 (EUR 5.38-8.07) per tonne CO_2. However, this estimate is subject to significant uncertainty.

2. Denmark's excess emissions of greenhouse gases

Danish greenhouse gas emissions have fallen only slightly since 1990 and significant efforts are still needed. The Danish government has made a revised statement of Denmark's expected excess emissions in relation to its commitment for the first Kyoto period, 2008 to 2012, provided no new initiatives are started. This factor will be termed *excess emissions* below, see figure 1.

Figure 1. Excess emissions in relation to Denmark's reduction commitments



Danish excess emissions are estimated at 25 million tonnes CO_2 equivalents per year, if calculations are based on Denmark's *legal* commitment under the EU Burden Sharing Agreement. This commitment is based on figures *not* corrected for the especially large import of electricity in the basis year, 1990. Danish excess emissions make up approx. 30 per cent of expected emissions for the period 2008-2012, significantly more than previously estimated.

At the Council meeting in connection with ratification of the Kyoto Protocol on 4 March 2002, Denmark did however achieve agreement on a *political declaration*. According to the declaration, Denmark's claim for adjusted electricity imports for the basis year, 1990, will be considered when individual Member State reductions in tonnes are finally determined in 2006. If the claimed correction is fully taken account of, Danish excess emissions will be reduced by 5 million tonnes CO_2 equivalents per year - in other words, excess emissions will be 20 million CO_2 equivalents per year.

The solution to the problem regarding correction for CO_2 emissions from electricity imports in the basis year is thus crucial to Danish excess emissions. See box 5.

The Danish government will use the political declaration mentioned above to work for a Danish reduction burden for 2008-2012 equivalent to 21 per cent of the 1990 level, corrected for electricity imports. The issue will not be decided until the individual Member States' permitted emissions in tonnes CO_2 equivalents are finally laid down in 2006.

Box 5. The basis-year problem

According to the commitments under the Kyoto Protocol, Member States are committed to reducing emissions of greenhouse gases in relation to *actual emissions* in the Protocol's basis year. However, Denmark's actual CO_2 emissions vary from year to year due to trading on the Nordic electricity market. In years of high rainfall, Norway and Sweden produce large quantities of cheap and environmentally friendly electricity based on hydropower, and this they export to Danish consumers. Danish power plants, in turn, use their excess capacity and increase production in years with less rainfall in order to export electricity to Norwegian and Swedish consumers. In this case CO_2 emissions take place in Denmark and burden Danish excess emissions.

There was a significant Danish import of electricity in 1990 and actual CO_2 emissions were thus considerably lower than in an average year. In 1990, Denmark's actual emissions were approx. 70 million tonnes CO_2 equivalents, whereas actual emissions corrected for electricity imports were approx. 76 million tonnes equivalents. In relation to Denmark's reduction commitment of 21 per cent, this difference of 6 million tonnes CO_2 in the basis year, 1990 means a difference of approx. 5 million tonnes CO_2 in permitted emissions for the period 2008-2012

The Danish government will use the political declaration from 4 March 2002 to work for a Danish reduction burden for 2008-2012 equivalent to 21 per cent of the 1990 level, corrected for electricity imports.

The estimated excess emissions for 2008-2012 are greater than has previously been estimated. This is due partly to the basis year problem, but also partly due to the fact that developments within recent years, in combination with a number of other factors, are expected to increase total energy consumption.

An emissions excess of 20-25 million tonnes CO_2 equivalents is a considerable challenge for Danish society. As a comparison, total greenhouse gas emissions from all types of transport comprise approx. 15 million tonnes CO_2 equivalents, and emissions from agriculture of CO_2, methane and nitrous oxides from livestock and arable farming comprise a total of approx. 13 million tonnes CO_2 equivalents.

Out of the excess emissions of 20 and 25 million tonnes CO_2 equivalents respectively, 10 million tonnes CO_2 are due to an expected rise in exports of electricity.

There is considerable uncertainty in estimating excess emissions ten years into the future. There is, however, no doubt that we are talking about a significant reduction commitment, which will be very costly for Danish society. The scope of the costs will depend on the initiatives set in motion to reduce emissions.

The lack of clarification regarding the basis-year problem and other uncertainties concerning the size of the excess emissions call for a climate strategy based on an objective of eliminating the excess emissions of 20 million tonnes CO_2 equivalents.

In 2006 when the basis-year problem has been clarified and forecasts for the period 2008-2012 are more certain, the climate strategy may be revised and new initiatives, if this should prove necessary.

3. What initiatives are available?

The EU quota trading system

The EU has put forward a proposal for a Directive on trading in CO_2 emissions quotas within the Community. In December 2002, the Council agreed on the Directive, which, however, still needs to be read and approved by the Parliament. From 2005 the Directive will introduce CO_2 quotas for enterprises in the energy sector - primarily electricity producers - and a number of energy-intensive industries. Enterprises are allocated a number of quotas each year. By the end of the year enterprises must have quotas corresponding to their actual CO_2 emissions for the year, see box 6.

Electricity producers and energy-intensive industries given quotas will be able to buy additional quotas from enterprises in other countries within the Community. By the use of flexible mechanisms they will also be credited with reduction initiatives implemented in Central and Eastern Europe and in developing countries, which they finance by buying project credits.

Box 6. The EU Directive on greenhouse gas emissions trading

The Kyoto Protocol and agreements regarding implementation of the Protocol outline a system where only the parties to the Protocol, the states, may trade in greenhouse gas quotas. The system, however, makes it possible for the states to authorise companies or individuals to trade, even though the state is still ultimately responsible for fulfilling the reduction commitment. The EU's Council of Ministers in December 2002 adopted a common position regarding such a system in which enterprises are allocated commitments and emissions rights that may be traded. Final adoption of the Directive is expected in the summer of 2003.

The Directive outlines a system in which an enterprise covered by quotas will receive a certain number of quotas at the beginning of each year. After the year has ended, the enterprise must hand over quotas to the state corresponding to the year's actual emissions. If an enterprise exceeds its emissions allowance - that is, if it does not have the amount of quotas adequate to cover the actual emissions - they must pay a tax of 40 EURO per tonne CO_2.

To begin with the Directive will cover CO_2 exclusively, but it has been drafted so it may eventually be applied to all six types of greenhouse gas. The Directive covers a number of enterprises, over a certain minimum size, within electricity and heat production, oil refining, and the metal, mineral, glass, biomass, and paper industries. It thus covers approx. 46 per cent of the EU's total emissions of CO_2 in 2010 which is equivalent to approx. 38 per cent of total emissions of all six greenhouse gases covered by the Kyoto Protocol.

An emissions trading system for electricity producers and energy-intensive industries, including possible use of flexible mechanisms, will leave it up to the individual enterprise to decide whether adjusting to its quota for excess emissions is achieved more cost-effectively through domestic reduction initiatives or through financing reduction initiatives abroad. This fits well with the Danish government's policy regarding the most cost-effective approach for society when achieving environmental objectives.

The regulation of quotas has the advantage of making sure that there are strong incentives to reduce CO_2 emissions, as excess quotas may be sold off. This again ensures a higher degree of cost-effectiveness in total reduction initiatives, so that reduction initiatives are carried out in the sectors and countries where implementation is cheapest.

Handing out free quotas - as oppose to imposing taxes - allows for a softening of the negative economic influence on competitiveness of electricity producers and energy-intensive industries. If a CO_2 tax were to be implemented at the same level - in order to create incentives across the different sectors - this would burden enterprises to a much larger extent economically.

Since the quota system applies to the entire EU, the competitiveness of individual enterprises will be influenced in a negative way only to the extent that their sector stands in competition with enterprises *outside* the EU. The quota system is therefore a way to ensure fairly homogenous competition between energy-intensive enterprises within the Community.

The individual Member States are faced with very different reduction commitments. The need for making more restricted CO_2 quotas will therefore vary. This may create uneven competitiveness for energy-intensive enterprises from country to country with regard to the economic effect of the number of free quotas allotted each enterprise. In Denmark the economic effect will be relatively unfavourable because of the large reduction commitment.

Costs of possible initiatives

Preliminary estimates show that the price of quotas and project credits (JI and CDM projects) is unlikely to exceed DKK 100 (EUR 13.46) per tonne CO_2 for the period 2008-2012. The most likely price level to be expected is DKK 40-60 (EUR 5.38-8.07) per tonne CO_2. The estimate is however connected with considerable uncertainty. In addition, it is based on the precondition that the US - as they have declared - will *not* ratify the Kyoto Protocol. If, in the future, the US should choose to ratify the Protocol, this is expected to result in a significant rise in prices, with quota prices of between DKK 100 (EUR 13.46) and DKK

200 (EUR 26.94) per tonne CO_2. The US will then be the most dominant buyer of quotas and credits compared to the other countries.

With a price level under DKK 100 (EUR 13.46) per tonne CO_2, the flexible mechanisms will give relatively higher CO_2 reductions per DKK spent, than will domestic initiatives.

Some domestic reduction initiatives may, according to assessments, compete with the flexible mechanisms when it comes to costs - in some instances they may even be cheaper. This applies especially to a certain reduction in electricity production based on fossil fuels, the use of heat pumps in district heating and decentralised combined heat and power, a number of minor energy-efficient initiatives, as well as recovering flare gas in connection with oil production, see table 1. The majority of the remaining domestic initiatives involve higher costs. For instance, the building of offshore wind turbines and biomass plants is very expensive at almost DKK 300 (EUR 40.40) per tonne CO_2 at the present technological level.

The total potential of the relatively cheap domestic initiatives is however not enough to eliminate Danish excess emissions. In comparison, there is an estimated considerable potential for implementing cost-effective reduction initiatives in developing countries and in Central and Eastern Europe.

Decisions regarding implementation of many of the initiatives mentioned above will take place within the framework of the CO_2 quota system that will cover electricity production etc. The extent of the application of these initiatives will thus be determined by enterprises - by whether or not they choose the most cost-effective solution.

Table 1. Initiatives for the fulfilment of climate commitments 2008-2012

	Reduction potential per year, million tonnes CO_2		Socio-economic unit cost, DKK per tonne CO_2	
Initiatives with large potential:				
Heat pumps - replace decentralised combined heat and power	Approx. 1½		-60	2)
Reduction of electricity production	Approx. 2-8		20-60	3)
Flexible mechanisms	–	1)	50-100	
Conversion from coal to natural gas	Approx. 3		150	
Heat pumps - replace centralised combined heat and power	Approx. 5		250	2)
Offshore wind parks	Approx. 2		270	2)
Further conversions from coal to natural gas	Approx. 5		280	
Conversion to biomass plants	Approx. 2½		290	2)
Storage in the underground on land or in oil fields	–	1)	160-310	
Initiatives with less potential:				
Window standards	0.2		-550	
Oil and gas boiler standards	0.1		-500	
Flare gas recovery	0.3		-330	
Heat pumps - replace oil-fired district heating district heating	0.8		10	2)
Establishment of biogas central plants	0.5		40	
Additional methane collection from landfills	0.1		180	
Changed feeding of dairy stock	0.4		590	
Use of bio fuels	0.5		740	
Tax per km on cars	0.5		1140	
Increased fuel taxes (DKK/litre)	0.6		1430	

Note: Initiatives based on current knowledge, which is considered very uncertain, or initiatives where CO_2 reductions are considered a side-effect of the initiative compared to its primary effect (e.g. afforestation) are not included in the table. The reduction potential describes the realistic potential in 2008-2012. For certain initiatives such as offshore wind parks there will be a further potential in the long run. Decisions regarding implementation of all of the initiatives with a large potential will take place within the framework of the CO_2 quota system covering electricity production etc.

1) Can cover all of Denmark's reduction commitment.

2) Calculations of unit costs are based on a less extensive application of the initiative than the potential mentioned. Unit costs may thus be *higher* if the whole of the potential mentioned is to be used in the period 2008-2012.

3) Within the framework of the EU quota system, only the part of the potential with lower marginal costs than the price of CO_2 quotas and credits will be realised. The interval has been calculated on the basis of a price of CO_2 quotas and credits at DKK 50 (EUR 6.73) and DKK 100 (EUR 13.46) per tonne CO_2 respectively.

There may be possibilities for reduction within agriculture, but the potential and socio-economic costs have not been adequately elucidated at present. It is therefore important that these possibilities are elucidated, so that possible cheap reduction initiatives within this field can be included in an overall strategy for eliminating Danish excess emissions.

It is important to note that domestic initiatives must be implemented within different sectors where the reduction of greenhouse gases is only one among several political considerations. Thus initiatives that from an isolated greenhouse-gas perspective are relatively expensive may still be carried through due to other considerations. Within the field of agriculture initiatives may be implemented out of concern for the aquatic environment, and within the energy field the concern may be for the security of supply.

The assessment of costs is only a ”snap shot” of the situation since there is a continuous development of technologies, and economic framework conditions may change. It is therefore necessary to always follow up on planning of the most cost-effective initiatives.

Renewable energy

Danish efforts in the reduction of greenhouse gas emissions have so far generally been based on expanding renewable energy sources for electricity production. This includes subsidies for wind turbines and promotion of bio fuels. However, these are relatively expensive initiatives.

Moreover, there is the fact that expansion of electricity production with renewable energy sources can never stand alone, since it does not in itself lead to a reduction of Danish excess emissions. This is because the emissions of greenhouse gases are traced to the producing not the consuming country. If expansion of electricity production based on renewable energy is to result in a reduction in Danish CO_2 emissions, expansion must be followed up by other concurrent initiatives. And these should either lead to a similar reduction of electricity exports based on fossil fuels, or lead to a corresponding application of flexible mechanisms (the buying of CO_2 quota/credits). If concurrent initiatives are not carried out, the fossil-based capacity released will lead to a corresponding increase in electricity exports, and there will be no positive effect on Danish excess emissions, see box 7.

Expansion with renewable energy sources should, however, also be seen in a wider energy-policy context, with emphasis is on long-term security of supply and the continuous development of new technologies.

Box 7. Relationship between developing renewable energy and CO2 reductions

Under the Kyoto Protocol emissions of greenhouse gases are traced to the producing not the consuming country. This means that total CO_2 emissions from fossil-based electricity production in Denmark will be added to Danish excess emissions.

In an open electricity market, expansion with renewable energy sources *will* reduce CO_2 emissions, but a substantial part of the reduction will help eliminate excess emissions not in Denmark but in other countries. This is due to the fact that expansion with renewable energy sources and electricity reductions will only lead to a corresponding increase in fossil-based electricity production for exports, unless initiatives are followed by a restriction of CO2 quotas for Danish electricity production.

This has been the situation in the Danish electricity sector during the last decade. There has been a substantial expansion of especially wind power and this has not been balanced with corresponding reductions in fossil-based electricity production. Denmark therefore has significant surplus capacity within electricity production. As there is also a rising capacity shortfall in the other Nordic countries, a substantial future electricity export to these countries is expected. If exports are realised it will lead to an approx. 10 million tonne increase in CO_2 emissions, which according to the Kyoto Protocol will be added to Denmark's emissions even though the electricity is consumed in other countries.

If an expansion of electricity production based on renewable energy is to result in a reduction in Danish CO_2 emissions, then the expansion must be followed by other concurrent initiatives. And these should either lead to a similar reduction in electricity exports based on fossil fuels, or lead to a corresponding application of flexible mechanisms (the buying of CO2 quota/credits).

4. A cost-effective strategy

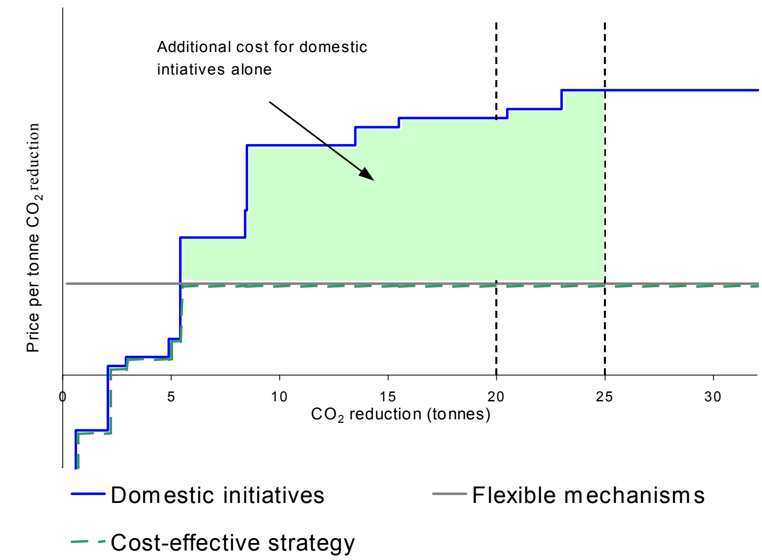
Continuing the current reductions policy will be expensive. Costs can be reduced significantly using a climate strategy based on implementing cost-effective domestic initiatives combined with the flexible mechanisms. Using such a strategy, the costs for Denmark to eliminate the excess emissions of 20 million tonnes CO_2 equivalents are estimated at DKK 1-2 billion (EUR 135-269 million) per year during the commitment period 2008-12 – depending on the price of the flexible mechanisms.

Alternatively, if the 20 million-tonne CO_2 equivalents reduction were to be achieved through the use of domestic instruments alone, and without using the flexible mechanisms, this would means costs to Danish society in the order of DKK 4 billion (EUR 538 million) per year – depending on the composition of the initiatives. If the excess emissions turn out to be 25 million tonnes CO_2, the costs will be in the order of DKK 5 billion (EUR 673 million).

Therefore, there is an annual additional cost of DKK 2-3 billion (EUR 269-404 million) for a climate strategy based solely on domestic initiatives, rather that a strategy that combines the most cost-effective domestic initiatives with application of the flexible mechanisms.

This additional amount is illustrated in figure 2 in the cost curve when the different domestic initiatives are ranked according to their cost effectiveness. Comparing this cost curve with the price level of the flexible mechanisms, gives the extra cost of a strategy solely based on domestic initiatives. The extra costs depend on the price of the flexible mechanisms, and the domestic initiatives. It should be emphasised that the cost curve is subject to a great deal of uncertainty.

Reduction costs for domestic initiatives compared with flexible mechanisms



Note: The cost curve is only an illustration, as the calculations are subject to significant uncertainty. The flexible mechanisms have been assessed at a cost of DKK 100 (EUR 13.46) per tonne CO_2 and it is unlikely that the cost will exceed this level. A cost level of DKK 40-60 (EUR 5.38-8.07) per tonne CO_2 is the most likely. Unit costs for several initiatives vary in relation to the size of reduction achieved. Furthermore, the precise potential is uncertain for some initiatives. The cost curve is based on the reduction potentials and unit costs stated in table 1. With regard to limiting production of electricity, the potential has been calculated on the basis of a quota price of DKK 50 (EUR 6.73) per tonne CO_2. Underground storage of CO_2 only includes on-shore storage, as storage in offshore oil fields involves a number of uncertain economic and safety factors deposits.

In order to ensure cohesion in reduction initiatives across sectors, the government has set an indicator of DKK 120 (EUR 16.16) per tonne CO_2 to be used as a basis for implementing domestic initiatives outside the area covered by the EU quota system. The indicator expresses the value of the CO_2 reduction to be included in calculations for specific initiatives. The value of any other benefits from an initiative can be added, for example other environmental benefits. Cost-effective reductions efforts require that initiatives are only implemented when the value of the benefits is greater that the costs.

The Kyoto Protocol sets a new agenda for reductions in greenhouse-gas emissions. The government considers that the objective to reduce Danish national emissions of CO_2 by 20 per cent in 2005 compared with 1988 is inappropriate. The national reductions objective from 1990 has been overtaken by international developments – the considerably greater reduction commitments linked to the Kyoto Protocol, and the global approach to applying the flexible mechanisms.

CO_2 quotas for electricity exports

Of the total excess emissions in 2008-2012, 10 million tonnes CO_2 are expected to come from increased exports of electricity. This increase is due to the fact that there is unused capacity in Danish fossil-based electricity production, and demand from Norway and Sweden is expected to increase.

It would not be appropriate to block Danish electricity exports, as this would probably mean that Norway and Sweden merely expand their fossil-fuel-based production of electricity, at the same time as Denmark loses export income.

When the Kyoto commitments apply from 2008-2012, a special consideration will be that the CO_2 quotas for the electricity sector are so restrictive that electricity exports produced by fossil fuels lead to a requirement that Danish producers of electricity must buy a number of CO_2 quotas/credits so that the Danish excess of emissions does not increase as a result of increases in electricity exports.

Contributions from the sector towards financing the overall reduction effort

The government's goal is that contributions to financing the overall national reduction commitments are divided between the different sectors in a balanced way, partly in relation to the amount the individual sector has already contributed to reducing emissions of greenhouse gases, and partly in relation to competition and administrative considerations.

The EU quota system will be an economic benefit for electricity producers. Even though CO_2 quotas are allocated free of charge, they will have a value for enterprises because they can be sold. The price of quotas will therefore comprise a cost of production, and to a large extent it will be transferred to the price of electricity. Higher electricity prices will mean higher income for electricity producers, and a corresponding burden on electricity consumers in households and businesses.

With this background it appears reasonable that the electricity sector co-finance a significant part of the total costs of eliminating the excess emissions of 20 million tonnes CO_2 equivalents, of which 10 million tonnes are due to expected increases in electricity exports. The electricity sector can contribute to financing by receiving fewer quotas free of charge, also in relation to the quotas they receive in accordance with the current quota regulations totalling 20 million tonnes CO_2 for 2003. There seems to be a basis for a significant reduction in the quotas allocated free of charge, without this implying a net burden on the electricity producers.

With regard to the energy-intensive industrial sectors, which are also subject to CO_2 quotas, the negative effects on competitiveness are less with a quota system than with a national CO_2 tax, as the quota system covers all the EU. However, some enterprises also compete with producers outside the EU and not subject to a quota system. Therefore, a survey, sector by sector, is required of the effects on competitiveness.

Households already contribute significantly to reducing the overall CO_2 emissions through energy and CO_2 taxes. Similarly, there are high taxes on transport (fuel taxes, registration duties, green taxes). Both households and the transport sector are already subject to higher taxes than the expected price of CO_2 quotas and credits. A further increase in taxes would therefore not be cost effective and it would lead to a relatively large loss in social welfare.

So far, agriculture has only been subject to few direct initiatives aimed at reducing emissions of greenhouse gases. The initiatives under the Action Plans for the Aquatic Environment to reduce nitrogen emissions from agriculture have, however, indirectly led to reductions in emissions of greenhouse gases from agriculture. This is because reductions in nitrogen emissions also reduce emissions of nitrous oxide. The initiatives and associated reductions in costs within agriculture have not, however, been adequately elucidated. Opportunities to implement cost-effective reductions initiatives will be analysed during the preparation of the forthcoming Action Plan for the Aquatic Environment III.

State efforts

Establishment of reduction projects is primarily a task for the private sector. This also applies for reduction projects carried out in other countries as part of the application of flexible mechanisms.

In some cases, state involvement in individual projects may be appropriate. In a number of areas, the state already has considerable expertise through its presence in the host country and cooperation in establishing environmental, energy, and development projects. This experience can secure more effective cooperation by the institutions in the host country.

Through becoming involved in project development over the next few years, the state can help ensure that the market for CO_2 credits is "up and running" earlier than would otherwise be the case. The state can thus help ensure that the necessary institutions are developed in the host countries in good time. State pilot projects can generate knowledge of the market for future use. In addition, credits linked to reduction projects can help Denmark meet its reduction commitments in 2008-2012.

However, there are also strong indications that the state should make use of international CO_2 credit banks and funds so that the risks in individual projects are shared with others. These CO_2 credit banks and funds already exist, and it can be expected that more will arise as trade increases.

State purchasing of CO_2 credits from international CO_2 credit banks and funds can also encourage the rise of this market, which should be mature when enterprises in energy-intensive sectors start buying CO_2 credits in large quantities.

Initially, the Danish government has earmarked DKK 130 million (EUR 17.5 million) in the 2003 Finance Act to establish reduction projects in Central and Eastern Europe (*Joint Implementation*). A number of projects are already in the offing, see box 8.

Furthermore, possible future utilisation of flexible mechanisms (CDM) will be included in the environmental initiatives in developing countries for 2003.

Box 8. State funding for *Joint Implementation* projects

Denmark will concentrate international environmental efforts in areas with the most cost-effective approach for society when achieving environmental objectives. As part of the support for Eastern Europe in 2003, the Danish government has therefore appropriated a reserve of DKK 130 million (EUR 17.5 million) to *Joint Implementation*.

The government wants to use this reserve in a number of climate projects in Central and Eastern Europe. The projects are to be carried out in close cooperation with the national authorities in the countries selected. The following projects are currently in progress:

Country	Project
Rumania	Conversion of district heating in five small towns from oil and gas to biomass, see box 3
Rumania	Expansion of geothermic plant for district heating in Oradea
Slovakia	Exploitation of high-yielding geothermic sources for heating supply in Kosice, a town with 120,000 inhabitants.
Slovakia	Exploitation of geothermic source in Oravice for heating and clean drinking water in the towns of Nizna and Tvrdosin in northern Slovakia
Slovakia	Establishment of 44 wood-pellet-fired heating plants, primarily in schools, and establishment of wood-pellet production from surplus wood.
Poland	Establishment of biomass-based district heating plant to supply the town of Pisz, 6,000 inhabitants.
Poland	

Exploitation of methane gas from existing landfills and sludge treatment in Zakopane for electricity and district heating.

These projects will provide significant reductions in CO_2 emissions. Completion of the projects will also mean considerably less pollution and significant transfer of technology and capacity. In addition, work with the projects will develop competence at the authorities in the countries so that, in future, the countries can reap full benefit from using the flexible mechanisms.

Danish enterprises needing to acquire CO_2 credits are unlikely to become involved in larger climate projects, but they will probably use CO_2 credit banks that specialise in financing and carrying out climate projects in Central and Eastern Europe and in developing countries. However, this market is still very new. Therefore, the government will use part of the reserve of DKK 130 million (EUR 17.5 million) to test the CO_2 credit banks. This will also contribute to getting the market “up and running”.