English summary

The present report from the Chairmen of the Danish Council of Environmental Economics focuses on three topical themes: the implementation of the EC Water Framework Directive, environmental (green) taxes, and the reduction of greenhouse gas (GHG) emissions in those parts of the economy not covered by the EU Emission Trading Scheme (ETS). These are policy areas which can be analysed and treated in isolation, but they have a lot in common. Green taxes form part of the regulation suggested in the report to implement the EC Water Framework Directive. Similarly, green taxes will play a central role if the national target for reductions in GHG emissions is to be achieved. Finally, green taxes are an important source of public revenue.

The chairmen's recommendations related to the implementation of the EC Water Framework Directive (Chapter I in the report) are presented first. This is followed by a forecast of Denmark's energy consumption and GHG emissions until 2020 (Chapter III) with special emphasis on GHG emissions in the non-ETS sector. Then, a review of the principles of green taxation is presented (Chapter II). Lastly, recommendations are made with regard to preferred instruments for reducing GHG emissions to the level of the national target (Chapter IV), together with a discussion on how to improve the regulation of road transport.

Water Policies

The EC Water Framework Directive sets targets for good ecological – chemical and physical – status for all bodies of water, i.e. ground water, lakes, river streams, fjords and coastal waters. Previous Danish Water Action Plans (VMP I, II and III) focused on emissions of nitrogen and phosphorus; the Water Framework Directive changes the policy objectives to focus on the ecological status of each of the bodies of water.

The Water Framework Directive's objective of a good ecological status allows site-specific variations in the ways the objectives for each body of water are achieved. For lakes, river streams, fjords and coastal waters, the measures to achieve the objectives require control of discharges of nitrogen and phosphorus from agriculture. The local variations in the initiatives required reflect the fact that local pollution control of the discharges from agriculture is the most cost-effective policy instrument for achieving the Water Framework Directive's objectives.

Chapter 1 presents analyses which indicate that retirement of environmentally sensitive cropland and the creation of wetlands are the most cost-effective technical measures for achieving local objectives. However, national regulation is still required to limit the use of nitrogen and phosphorus and thereby the general environmental damage such as from emissions of ammonia and laughing gas.

The national regulation

The use of phosphorus is regulated by a phosphorus tax on mineral feed. It is recommended that a nitrogen tax on commercial feed stuffs and fertilisers should also be introduced to replace the existing crop-specific nitrogen quotas. This would reduce the compliance costs as well as the administrative costs of national nitrogen regulation. A system of tradable nitrogen permits is an alternative to the nitrogen tax. This could be implemented by allowing trade in the existing nitrogen quotas.

A nitrogen tax should also regulate the part of the laughing gas discharges that comes from fertiliser application, and livestock discharge GHGs through the release of methane. It is recommended that these discharges should be regulated by a tax per animal. The tax should be reduced for farmers that apply technical measures to reduce the discharges. This is discussed more thoroughly in the section about greenhouse gas abatement.

The existing pesticide tax varies with the retail price of the different categories of pesticides. It is recommended that

the tax should instead be based on the potential environmental risk and damage of the different pesticide categories.

Extraction of ground water for drinking water and industrial purposes also impacts the water bearing of streams and thus the physical quality of the water. Today, the water tax mainly serves as a means for generating revenue. Only households pay the tax on water consumption even though they account for less than half of the total water consumption. It is recommended that the water tax should be differentiated locally to reflect local externalities caused by the scarcity of ground water. A scarcity tax should target the extraction of ground water rather than water consumption and should be paid by all consumers, including companies.

In addition to the existing tax on water consumption, the discharge of waste water is also taxed. Some groups of companies that discharge large quantities of waste water are exempted from the tax. This exemption is not appropriate, if the objective of the tax is to control environmental damage.

Local regulatory measures

Analyses from the National Environmental Research Institute indicate that the achievement of the Water Framework Directive's objectives for streams requires the termination – or reduction – of maintenance of the streams. This is a direct consequence of the objective of a good physical status. It is expected that this will induce flooding of agricultural land next to streams and thus land retirement.

For lakes and coastal waters, it is possible to allow for more flexibility when selecting technical measures for achieving the Directive's objectives. Land retirement and the creation of wetlands are generally the most cost-effective technical measures, but the opportunities for achieving the objectives are site-specific and thus vary locally. Since the individual farmer has the most accurate knowledge of his production technology, ideally he should allocate the abatement measures on his farm. However, empirical evidence from Water

Action Plan III clearly indicates that voluntary agreements alone are not sufficient to achieve the objectives.

To ensure that the Directive's objectives are achieved, it is recommended that voluntary agreements should be supplemented with a charge on cultivation of environmentally sensitive land. The proposed regulation mechanism consists of 4 components: a provisional programme of measures, a cultivation tax, an option voluntarily to set up an alternative programme of measures, and, lastly, subsidies for applying the technical measures.

The proposal is briefly described as follows: In 2009, the environmental authorities announce for each sub-catchment a provisional programme of measures aimed at achieving the Water Framework Directive's objectives. The provisional programme of measures involves the retirement of environmentally sensitive land. The provisional programme allocates the abatement efforts in terms of land retirement fairly and equally among farmers with environmentally sensitive land in the sub-catchment. The environmental authorities also introduce a tax on the cultivation of the environmentally sensitive land included in the provisional programme of measures. The cultivation tax is set at a level sufficiently high to ensure retirement of the appointed land. The cultivation tax takes effect from 2012.

Meanwhile, the farmers with cropland in the sub-catchment are given the opportunity – as one united group or in subgroups – voluntarily to set up an alternative programme of measures to achieve the abatement efforts required for the farms involved. The alternative programme can include other measures for the abatement of nitrogen and phosphorus loads than land retirement and can be applied to other areas than the areas targeted in the provisional programme of measures. If the environmental authorities agree that the alternative programme of measures is sufficient to achieve the abatement efforts required for the farms involved, the alternative programme replaces the provisional programme of measures and the farms involved are fully exempted from the cultivation tax. If the alternative programme is not approved, the farms in the sub-catchment can still choose

individually whether they will participate in the provisional programme of measures or be subject to the cultivation tax. Thus, the proposal implies exemption from the cultivation tax for all farms that participate in the provisional programme of measures or an approved alternative programme of measures. All other farms must pay the cultivation tax. The level of the cultivation tax will ensure that almost none of the farms will choose to pay the tax. In this way, the mechanism will ensure the realisation of the targets in the Water Framework Directive.

Agreements that lead to exemption from the cultivation tax are binding on the farmers. Whether the actions in the final programme of measures are implemented will be continuously monitored. If a farm does not fulfil its agreements, the cultivation tax will be imposed on the specific areas where the agreed measures are not applied. The programme of measures can be adjusted every 6th year according to the provisions of the Water Framework Directive.

It is recommended that the existing voluntary agri-environmental measures under the EU's Rural Development Fund should be adjusted to facilitate the achievement of the Water Framework Directive's objectives. This ensures that voluntary agreements can enter into the final programme of measures, such that farms agree to receive subsidies for changing cultivation procedures and land allocation to reduce environmental damage from nitrogen and phosphorus leaching. The subsidies are fixed rates that equal the average costs of applying the abatement procedures. Similar voluntary agreements have existed for a decade as part of the Rural Development Programme under the EC's agricultural policy.

Previous analyses prepared for the ministries involved in the implementation of the Water Framework Directive indicate that it would require the retirement of 75,000 ha of agricultural land to implement the Directive. This corresponds to about 3 per cent of total agricultural land. Model analysis indicates that this would lead to limited economic costs for society of about DKK 200 million per year.

Subsidies for applying environmentally friendly production procedures are an important part of the proposed mechanism. Therefore, it is recommended that Denmark should utilise the planned reallocation (modulation) of the EC agricultural subsidy funds to ensure part of the funding for the achievement of the Directive's objectives. The reallocation of the EC agricultural funds involves 10 per cent of the general agricultural subsides being transferred to the Rural Development Programme in 2012. Amongst other things, the programme contains an agricultural subsidy scheme for environmentally friendly production. It is recommended that the options of voluntarily transferring more funds from the general subsidy scheme to the Rural Development Programme should be used, because this does not require national part-funding. Utilisation of the subsidies from the Rural Development Programme implies lower costs to the Government than other intervention schemes such as the compulsory purchase of farm land.

The Water Framework Directive allows for exemptions from the Directive's objectives, if the costs of achieving the objectives are disproportionately high. It is recommended that this assessment should be based on cost-benefit analyses, in which costs and benefits are compared for the specific recipient and sub-basin. However, it is a political decision to decide what "disproportionately high" means.

Projection for energy consumption

Climate and energy policy has increased focus on the development of energy consumption and emission of GHGs. Energy consumption in Denmark has increased by approximately 15 per cent since 1990. In the same period, production has increased by approximately 45 per cent. This indicates a partial divergence between energy consumption and economic growth. Chapter III presents a projection of energy consumption in Denmark and the resulting energy-related emissions of the GHGs, CO_2, methane and laughing gas. This is supplemented with a projection from the Danish National Environmental Research Institute of the non-energy-related emissions of

GHGs from agriculture, primarily methane and laughing gas. The projection forecasts an increase in energy consumption due primarily to a significant increase in petrol and diesel consumption for road transport.

There are a number of objectives in Danish climate and energy policy involving emission of GHGs, energy consumption, and renewable energy. Although end-use energy consumption is rising, increasing efficiency in the production of electricity and district heating means that net energy consumption is expected to decrease more than the national target of a 4 per cent reduction in 2020. The share of renewable energy in total energy supply is projected to increase to 40 per cent in 2020, given the current regulation using subsidies, the assumed development in energy prices, and the CO_2 quota price. Since the target is a share of 30 per cent, this is expected to be realised.

The Kyoto Treaty obliges Denmark to reduce the emission of GHGs by 21 per cent on average during the period of 2008-12 relative to the emission level in 1990. The projection indicates that without further initiatives the total Danish emission of GHGs will lack a reduction of approximately 12¼ million tonnes of CO_2 equivalents for each year of the period. This is a smaller deficit than assumed in the Danish National Allocation Plan 2008-12. It is therefore possible that the National Allocation Plan can be achieved with the initiatives specified in the plan, such as buying quotas in the EU ETS and CO_2 reductions outside Denmark.

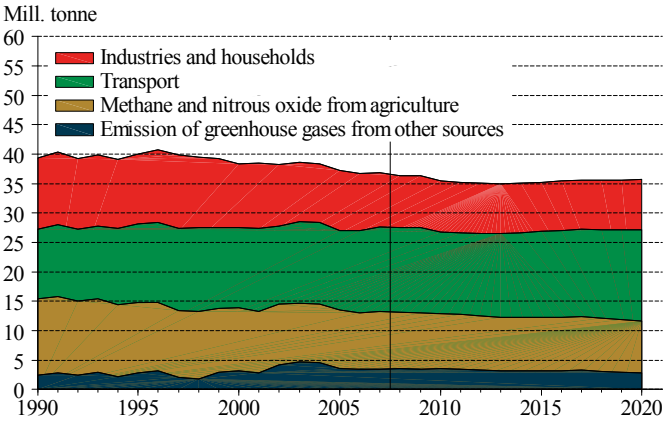
The projection of energy consumption is based on the Chair of the Economic Councils' central macroeconomic projection from the autumn of 2008. However, the economic slowdown seems to be worse than expected then, which indicates that energy consumption and the emission of GHGs could be smaller in 2008-12 than estimated in the present projection. This will reduce the need to buy quotas or emission rights outside Denmark.

Denmark and the EU are obliged to reduce the emission of GHGs. Regulation in EU is not the same for the whole economy. The economy is divided into sectors that are

within the Emission Trading System (the ETS sector) and sectors that are outside the Emission Trading System (the non-ETS sector). For the two parts of the economy there are different regulations and objectives. The ETS sector is regulated by the EU quota trading system, while national targets have been determined for the non-ETS sector.

In 2005, the emission of GHGs from the non-ETS sector in the Danish economy was 37.2 million tonnes. The national reduction target for Denmark is that the emissions should be reduced by 20 per cent to 29.9 million tonnes in 2020. However, the projection estimates that emissions from the non-ETS sector will only be reduced by approximately 4 per cent from 2005 to 2020. This forecast is based on the expectation that non-energy related emissions, especially from agriculture, will decrease, while the energy-related CO_2-emission, which is ⅔ of the emission from the non-ETS sector, is expected to remain the same. Increasing consumption of transport fuels in the future implies a substantial increase, while the emission from industries in the non-ETS sector and households is estimated to decrease. On this basis, the domestic reduction in the emission of GHGs in the non-ETS sector is estimated to be approximately 1½ million tonnes in 2020 relative to the level of emission in 2005. This implies a deficit of approximately 6 million tonnes in 2020. So additional initiatives are needed to achieve the reduction in GHG emission required in the non-ETS sector, see figure A.

Figure A *Emission of greenhouse gases from the non-ETS-sector*



Note: The emission of greenhouse gases from the non-ETS sector was 37.2 million tonnes of CO_2 equivalents in 2005, and the maximum allowed emission in 2020 is 29.9 million tonnes. The vertical line in the figure indicates the beginning of the projection period. Industries and households include energy-related emissions of CO_2. Transport includes emission of CO_2 from petrol and diesel for transport. Emission of greenhouse gases from other sources includes e.g. energy-related emission of methane, nitrous oxide, and gases from industry.

Source: Statistics Denmark, *National Accounts*, and own estimates.

Green taxes

Green taxes or tradable emission permits are generally cost-efficient economic instruments in environmental policy. Environmental improvements are often achieved at lower cost by using these types of economic regulations rather than command and control regulation. Green taxes should be levied as close to the environmental damage as possible.

Several of the so-called green taxes in Denmark have been introduced without a prior assessment of the environmental damage and without an environmental target. This may be because there is insufficient knowledge of the environmental effects of various pollutants and their costs. The green taxes should be continuously adjusted to reflect new

knowledge on the amount and the monetary value of the environmental damage.

Economic measures in environmental policy are most simple to use in cases where the affect on the environment is independent of the location of the polluter. This holds in the case of GHG emissions. Economic regulation can be used in some cases even when the environmental damage does depend on the location of the emission. Complementary local regulation may, however, be required and can imply significant administrative costs. It is difficult to use economic instruments when emissions cannot be measured or when the polluter cannot be traced. Cross-border trading may also reduce the effectiveness of green taxes.

All polluters, i.e. services, industries and households, should pay the same green tax if the tax is levied for an environmental purpose. This ensures that environmental improvement is achieved at the lowest possible cost.

Environmental regulation increases production costs and thereby consumer prices. This reduces the labour supply as the real wage is reduced. Taxes or auctioned tradable emission permits generate public revenue. This can be used to reduce income taxes or other distortionary taxes, which in turn will reduce or even remove the negative impact that environmental regulation may have on the labour supply. If emission permits are distributed at no cost or if polluters are compensated for the extra costs of green taxes, no revenue will be available to reduce other distortions in the tax system.

The EU ETS is an example of a permit system where the permits are distributed at no cost. The EU has, however, decided that this free distribution should be gradually abolished by 2020. This will give public revenue which can be used to reduce other distortionary taxes and improve economic efficiency compared to the current system. Furthermore, free distribution of CO_2 quotas can distort the structure of production and investment, because too many productive resources and investments are retained in polluting industries.

In the non-ETS industries (i.e. services and industries not covered by the ETS quota system), there is a deduction scheme that reduces the payment of CO_2 taxes for energy intensive industries. This exists to ensure equal treatment of similar industries in the ETS and non-ETS sectors. The deduction scheme should be removed at the same time as auctioned quotas are introduced. This will create better incentives for CO_2-saving behaviour in the non-ETS sector.

Taxes introduced for the purpose of raising government revenue should only be levied on final consumption. The least price-elastic commodities should be taxed the highest because this minimises the socio-economic costs of raising a given level of revenue. In this case, industries and services should not pay a revenue-motivated tax on their intermediates, because this distorts the input choices of producers.

Economic effects of higher green taxes

Green taxes on household consumption and intermediates in industries and services affect consumption of commodities in households and the use of intermediates in industries and services directly and indirectly. These effects have been analysed in a detailed general equilibrium model of the Danish economy. Amongst other things, the model calculates the welfare consequences of increasing green taxes on household consumption of commodities, services and leisure. The resulting changes in the level of several air pollutants are determined by the model, but it does not account for the welfare effects on the households from the altered pollution level.

The economic consequences of increasing the level of green taxes depend greatly on how the resulting revenue is spent. A public revenue of DKK 5 billion collected by proportionally increasing all green taxes and spent on increasing the personal tax-free allowance implies a socio-economic cost of DKK 1.5 billion – not counting the value of changed environmental conditions. However, the socio-economic cost is reduced to approximately DKK 1 billion if the reve-

nue is spent on reducing the bottom tax rate. The reason is that lowering the bottom tax rate stimulates the labour supply, and thereby economic activity. The labour supply will be stimulated even more if the revenue is spent on reducing the top tax rate.

It is often thought that higher green taxes increase inequality. One reason is that inequality is often measured as differences in annual income rather than annual consumption. Annual consumption may arguably be a better measure for lifetime income than current income, which can be affected by several temporary factors. It is therefore from a lifetime perspective more relevant to measure the distributional consequences of green taxes using differences in annual consumption. High income households (measured by total consumption) pay more in green taxes than low income households and households outside the labour force. This holds in particular for green taxes on transport while green taxes on water and electricity represent a higher consumption share for low income households.

How the revenue resulting from higher green taxes is spent, determines the distributional consequences of higher green taxes. Low income households will gain from higher green taxes if the personal tax-free allowance is increased. The distributional consequences are closer to neutral if the bottom tax rate is reduced instead. However, low income households also gain in this case.

Progressive green taxes, i.e. where only consumption above a certain level is taxed, cannot be recommended. Households with low consumption levels will not have sufficient incentive to reduce consumption of polluting commodities. The environmental effect does not depend on whether the consumer is rich or poor. Therefore, from an environmental perspective, green taxes per unit of pollution should be equal across all consumers. Distributional concerns should be addressed by other means, e.g. via the income tax system or by direct income transfers.

The analyses in the chapter show that there are differences in the economic distortion caused by different types of

green taxes. Without taking the value of environmental improvements into account, higher energy taxes or taxes on transport cost 40 per cent of the revenue if combined with an increase in the personal tax-free allowance. Higher taxes on water or waste cost only 20 and 30 per cent of the revenue, respectively. Green taxes levied for the purpose of raising public revenues should be introduced where the distortion is lowest, while distributional concerns can play a role in deciding how the revenue is spent.

Regulation of greenhouse gases and energy

Green taxes or tradable quotas are especially suitable for the regulation of GHG emissions. The reason for this is that the greenhouse effect is a global externality, because it is the total amount of CO_2 or CO_2-equivalents in the atmosphere that determines the amount of global warming. The marginal damage from the emission of GHGs is therefore independent of the location of the emission source. Hence, the optimal tax per CO_2-equivalent emitted should be the same for all polluters.

Tradable emission quotas and green taxes are parts of a complex interplay in the EU regulation of emissions of GHGs. The EU's climate policy and the possibilities for Denmark to fulfil its GHG reduction obligations in the quota and in the non-quota sectors are discussed below.

EU regulation of greenhouse gas emission

The obligation to reduce emissions of GHGs divides the economy into two parts. Energy intensive industries are regulated by the common ETS, while the other part of the economy has national reduction targets. The separation of the economy into two parts implies a risk that the total emission reduction costs will be larger than necessary, since the marginal reduction cost might differ between the two. The marginal reduction cost in the ETS sector is the price of an emission quota. The marginal reduction cost in the non-ETS sector depends on the national reduction possibilities and the reduction obligation agreed upon in the EU. There

is no mechanism to ensure equal marginal GHG emission reduction costs in the ETS sector and the non-ETS sector in the individual member states.

The analyses presented in this report indicate that the marginal reduction costs in the non-ETS sector will be significantly higher than the expected quota price in the ETS sector. This indicates that the total emission reduction is not cost-efficient. In other words, Denmark could reduce total emissions further for the same price in terms of welfare costs if a larger part of the emission reduction was made in the ETS sector.

In the EU, Denmark should support mechanisms that effectively equalise marginal reduction costs in the ETS and non-ETS sectors. One such possible mechanism could be to allow EU-member countries to increase or reduce their reduction target for the non-ETS sector by trading CO_2 quotas in the ETS quota market. Countries with high reduction costs should be allowed to purchase quotas and thereby ease their emission reduction obligation correspondingly. Countries with low emission reduction costs in the non-ETS sector should be allowed to issue quotas in the ETS sector if their actual emission in the non-ETS sector is less than their obligation. This would lead to the same marginal GHG emission reduction cost in the ETS and the non-ETS sector (the quota price), if all countries act to minimise their emission reduction costs. I.e. this mechanism minimises the total cost of emission reductions in the EU.

The EU meeting in December 2008 made it clear that the ETS will continue for the near-term future. It is therefore necessary to consider how differences in the cost of reductions between countries can be cushioned. Meanwhile, Denmark should argue in favour of rules that allow reduction obligations to be traded between member states without limits on the amount member states can buy or sell.

Along with Luxembourg and Ireland, Denmark has the largest obligations to reduce emissions of GHGs in the non-ETS sector. These obligations vary between the EU member states according to their wealth measured by GDP per

capita. Some countries are only committed to very limited reductions in emissions of GHGs. This induces differences in reduction costs across EU member states. The same reduction in total emissions can be achieved at a lower cost if countries with high marginal reduction costs are allowed to pay for (further) reductions in countries where it is easy to meet the obligation to reduce emissions. This will contribute to an equalisation of the reduction costs in the non-ETS sector between countries.

The existence of differences in reduction costs between the EU-countries can lead to an unfavourable shift in the production taking place between the EU member states in the non-ETS sector. If Denmark imposes a high tax on all emissions of GHGs in the non-ETS sector, it will raise the costs of production in energy-intensive industries and – in particular – in the agricultural sector. If our neighbouring countries do not impose the same high tax on GHGs, this can lead to a movement of agricultural production from Denmark to these countries. There will be costs associated with the movement of production both at the individual level of businesses as well as on the national level. However, the total emission of GHGs will be unaffected given that all countries meet their obligations to reduce GHG emissions.

Moreover, the agricultural sector faces a problem of relocation of production to countries outside the EU similar to that faced by the energy intensive firms in the ETS sector. Competitors outside the EU in countries without binding targets on GHG emissions have lower costs of production. This makes it profitable to move the production to places without restrictions on emissions of GHGs.

Reduction of greenhouse gases in the non-ETS sector

EU guidelines limit the amount of reduction in the non-ETS sector a country can buy due to the so-called supplementary principle. This implies that a certain part of the required reduction must be met by domestic reductions. The guidelines have been interpreted such that no more than half of

the total reduction can be bought in other EU member states or outside the EU.

Given these limitations and given the high reduction costs in the Danish non-ETS sector documented in this report, Denmark should buy as much of its reduction obligation as possible in other countries.

The remaining part of the reduction obligation must be met by domestic reductions. The main sources of domestic emissions of GHGs are households (heating and transport), the non-ETS regulated industries (including transport) and services, and agriculture. In agriculture the GHG emissions consist of energy-related emissions of CO_2 and non-energy-related emissions of methane and laughing gas from animal husbandry and the application of fertiliser. To start with, the reductions in the non-ETS sector should be organised such that the marginal reduction cost per CO_2-equivalent is the same for all kinds of GHG emission.

The necessary reduction in the non-ETS sector should be achieved using general instruments. Industry or technology-specific goals or instruments are not normally suitable because they can raise reduction costs. General economic instruments, such as taxes, are cost-effective and technologically neutral. The choice of technology is handed over to companies and households. For instance, if a tax is imposed on oil and gas used for heating, some will insulate their homes while others will switch to distant heating, install an electric heat pump or lower the room temperature.

The desirability of cost-effectiveness makes a strong case for higher taxes on emissions of GHGs in the non-ETS sector. Cost-effectiveness implies that the tariff should be the same for all kinds of emission. It also implies that a tax should be imposed on non-energy related emissions from the agricultural sector.

Reduction in the emissions of greenhouse gases from the agricultural sector

Approximately one third of the emissions from the non-ETS sector are non-energy related emissions. Most of these emissions by far consist of emissions of methane and laughing gas from the agricultural sector. Although there is regulation of the handling of manure and fertiliser, a clear price signal for this kind of emission is needed. It seems clear that emissions of methane and laughing gas should be reduced as a part of the total Danish reduction of emissions of GHGs from the non-ETS sector. Emissions of methane can be regulated by a tax on animals combined with discounts for initiatives that reduce emissions per animal. Emissions of laughing gas can be regulated by a tax on nitrogen or tradable nitrogen quotas. This has been suggested as an instrument in relation to fulfilling the water framework directive.

It is necessary to impose taxes on non-energy related emissions of GHGs to obtain a cost-effective reduction of the emissions. Analysis in Chapter II in the report shows that it requires very high taxes on other industries and services to meet the reduction target in the non-ETS sector if the agricultural sector is exempted from taxes on GHG emissions.

If the agricultural sector has to pay the full tax for all of their non-energy related emissions of GHGs, this will raise costs markedly. Reallocation of production within the EU is a problem due to differences in taxation. This is undesirable since the differences in taxation reflect an inappropriate regulation of the emissions of GHGs in the EU.

Therefore, it can be argued that there should be a temporary compensation scheme similar to the free allocation of quotas that applies for firms in the ETS sector until 2020. For the agricultural sector, a part of such a compensation scheme could take the form of subsidy for technologies that can reduce incentives to relocate animal production to other countries. This could for instance be a subsidy for biogas.

Since a large part of the problem with movement of production is caused by the risk that the tax on GHGs in Denmark will differ substantially from the tax in surrounding countries, the tax should be introduced gradually and gently. This also provides an opportunity to develop the technological solutions needed to reduce the cost of reducing GHG emissions in agriculture.

Reduction in the remaining parts of the non-ETS sector

The remaining emissions from the non-ETS sector are energy-related emissions coming from households' use of heating and transport, and from industries and services. If the reduction of emissions of GHGs is to be cost-effective, emissions from these sources – including industry – will have to be taxed equally and the necessary tax rate is likely to exceed the expected price of a CO_2-quota in the ETS sector.

Emissions from the transport sector are growing, and it is expected that they will represent approximately 45 per cent of the emissions from the non-ETS sector in 2020. Because of the importance of the sector, there are reasons for looking closely at the regulation and effective taxation it is subject to. To fulfil the obligation to reduce emission of GHGs, the CO_2-tax on transport fuels should be at least equal to the uniform tax on other kinds of emission of GHGs. In practice, the possibility of cross-border trade limits the scope for raising fuel taxes unless Germany and Sweden do the same. Given this limitation it should be considered how incentives to reduce consumption of fuel can be incorporated into the design of any forthcoming road-pricing scheme, cf. the section on taxation of traffic below.

Since a considerable – and growing – amount of the emission of GHGs is related to freight transport and trucks, road pricing should include trucks and other kinds of commercial transport.

Household use of energy for individual heating is the largest source of the emission of greenhouse gases in the non-ETS sector. Individual heating is quite insensitive to changes in

the amount of taxation. This is due to both the fact that the existing tax is high and that the possibilities for switching to other sources of heating are limited.

The difference between the quota price and the GHG tax in the non-ETS sector creates a situation, where there is a potential welfare gain from moving consumption of heating from the non-ETS sector to the ETS sector. If this difference is expected to persist, it can be argued that the state should promote such a switch by expanding the district heating transmission network. Some analyses indicate that an expansion of the district heating transmission network can be an economically profitable way to reduce emissions from the non-ETS sector. The existing overall plan for the outreach of different sources of heating (i.e. natural gas and district heating) is 20 years old. It is therefore recommended that analyses should be carried out that can form the basis for a revision of the existing division into areas with district heating, natural gas and individual heating.

Emissions of GHGs related to the production of district heating are regulated by quotas, while the emissions related to individual burning of oil and gas belong to the non-ETS sector. In this way, emissions from the non-ETS sector could be reduced. The direct result would be an increase in emissions from the ETS sector. However, since the total emissions from this sector are regulated by the total amount of quotas, proportional reductions must be made somewhere else in the sector possibly in another country.

There can be other changes in the use of technology that can move emissions to the ETS sector. Some of the technologies which are expected to play a role in this connection are the introduction of electric cars and increased use of electric heat pumps.

Basically, these technologies would be promoted by a higher GHG tax in the non-ETS sector. Special arguments are therefore needed in order for specific technologies to be promoted. However, the availability of e.g. district heating for a given household can only be changed by a political decision.

An illustration of instruments to reduce greenhouse gas emissions to the national target

The forecast of GHG emissions in the non-ETS sector in Chapter III showed that without additional initiatives the national target for GHG emissions will be exceeded by 5.8 million tonnes of CO_2-equivalents. Chapter IV of the report illustrates how a green tax on GHG emissions together with additional instruments could be employed to reach the national target. In the scenario sketched, an additional tax on energy-related CO_2-emissions of around DKK 400 per tonne in the non-ETS sector would be needed to reach the target. The exact size of the tax is rather uncertain and depends on the effectiveness of other instruments employed.

This would lead to a sizeable gap between the tax on energy-related CO_2 in the non-ETS sector and the expected quota price in the ETS sector. This, together with an expansion of the district heating network would reduce emissions from individual heating by 1 million tonnes of CO_2-equivalents. In addition, a reduction of 1½ million tonnes will come from an increased use of biofuels in transport (private and commercial), and an increase in the use of electric cars.

Non-energy related emissions from agriculture are assumed to be reduced by 1 million tonnes using a range of instruments. This is a significantly smaller reduction compared with a situation where non-energy emissions are also subject to an equivalent tax of DKK 400 per tonne CO_2-equivalents as shown in the analysis in Chapter II.

The remaining reduction of 2 million tonnes of CO_2-equivalents needed to reach the emission target is assumed to take place outside Denmark by utilising the opportunities available in the EU agreement for buying emission reductions in other countries.

It should be stressed that the estimated effects of the different instruments and taxes are uncertain. The situation in 2020 vis-à-vis Denmark's reduction target depends on macro economic and technological developments which can

deviate from the assumptions made in the projections involved. Forecasts and instruments should be updated and evaluated on a continuous basis to judge whether emission reductions are developing as expected.

Taxes on energy use

Taxes on the use of energy can be motivated by one or more of three main arguments: concern for the environment, security of energy supplies, and as an instrument to raise government revenue. The first and second of these seek to correct for externalities stemming from energy consumption. Generally, taxes which correct for externalities should be levied equally on both households and industries. Taxes on energy for the sole purpose of raising government revenue should be levied on households only. This is to avoid distorting the allocation of the industries' use of inputs.

To the extent these three main concerns are properly addressed by the tax system, it is difficult to argue the need for a national target for the total amount of energy used. If the Danish national target for total energy use is maintained – due to political constraints – it should be viewed as an externality, and households as well as industries should be taxed so that Denmark can reach the target.

A tax based on the emission of air pollutants, such as CO_2, SO2 and NOX (particles), should be levied uniformly on households and industries. That is, all polluters should pay the same for a given amount of emission of air pollutants. Consequently, a tax reflecting the emission of particles should be levied on households' use of firewood and other biofuels. Taxes levied to increase the security of energy supply should be limited to the use – by households and industries – of oil and natural gas. The supply of coal from reliable trading partners is not considered to be limited.

The existing general energy tax needs focusing and rethinking. In its current form, it is targeted neither to raise public revenue efficiently, nor to address environmental externalities or concerns about the security of energy supplies. It is recommended that the present tax on energy should be

decomposed into separate elements, each addressing different externalities and the need for public revenue generation. Households would have to pay all elements of the new tax, whereas services and industries would only pay the parts which regulate externalities or reflect concerns about security of energy supplies. This would increase the transparency of the marginal welfare costs attributed to each externality.

The changes to the structure of the general tax on energy entail modifications in the tax payments of both households and industry. Households would have to pay taxes on biofuels, whereas the tax on energy use for heating purposes in services and industries would probably be lower under the new scheme. However, the direction of the change in the total energy tax payment for households and services and industries depends on the value assigned to the different externalities and the need for additional public revenue.

The regulation of GHG emissions should be governed by a general tax on CO_2-equivalents emitted by households and services and industries not covered by the EU ETS. The tax rate should be continuously adjusted in order to reach the target for CO_2 reduction in 2020, cf. above. This is likely to require a large increase compared to today's level.

It is recommended that the current tax on GHG emissions from electricity generation (levied on consumption) and the production of district heating should be removed, since these industries are covered by the EU ETS.

Taxes on transport

Today's taxes on transport come in the form of fuel taxes, taxes when buying a vehicle, and an annual tax for owning a vehicle. The latter taxes are differentiated according to either size or fuel efficiency, and in some cases purpose of use (i.e. business or private). The system is not well designed to account for the externalities attributed to transportation, such as congestion, noise, accidents, and local and global air pollution. The Chairmen of the Councils' recommendation is to look into the possibilities for introducing

an intelligent road-pricing scheme. The advantage of a road-pricing scheme is that the tax payment can be made to depend on where, when and with what type of vehicle transportation take place. This would allow the payment structure to address a greater range of externalities resulting from transportation. With the introduction of road-pricing, taxes levied when buying a vehicle should be reduced. To some extent, taxes related to household ownership of vehicles could be maintained for reasons of public revenue generation.

Since the emission of GHGs depends entirely on fuel use, this externality can be corrected by fuel taxes. In addition to regulating GHG emissions, fuel taxes should possibly include an energy security element. Such a system is likely to lower the direct taxation of transportation fuels compared with the current level. However, depending on the costs of other externalities, the price of using vehicles would increase.

Whether the total amount of taxes paid for a given amount of driving will increase or decrease will depend of the type of vehicle used, the time and the place of use. Trucks and lorries will face an increase in transportation taxes, since the current tax on freight traffic is lower than the external effects.