ENGLISH SUMMARY

The present report from the Chairmen of the Danish Council of Environmental Economics contains four chapters. Chapter 1 presents an analysis of the state of the agricultural sector in Denmark and its impact on the environment. Chapter 2 examines the recreational value of land and Chapter 3 looks at the Danish energy consumption and greenhouse gas emissions. Finally, Chapter 4 discusses the future of international climate change agreements in light of the outcome of the recent COP15 meeting in Copenhagen.

Chapter 1: Danish agriculture

Agriculture has always been a very important industry in Denmark, and has played an important role in the country's exports and in creating jobs in rural areas. This role has been diminishing in recent decades. In 1966, the agricultural sector, including the food processing industry, accounted for 8 per cent of total national production. This number had declined to 2 per cent in 2008. Despite the decreasing economic importance of agriculture, the level of support to the sector – mainly from the EU – has remained at a high and stable level.

Notwithstanding its decline in economic importance, the sector plays a vital role in land-use management as agricultural land covers 2/3 of the total area of Denmark. The sector impacts heavily on the environment through excess nutrient run-off, the adverse effects of pesticide use and the emission of greenhouse gases.

The agricultural sector in Denmark is now facing economic problems. Productivity growth, which historically has been high, has been falling dramatically in recent years. This, together with increasing costs and falling prices of agricultural products, is putting pressure on profits. In the absence of capital gains, this situation could result in negative total returns in the sector.

To ensure a sustainable future for Danish agriculture, both economically and environmentally, it is necessary to change the way the sector is currently regulated: Danish agriculture should operate on the same terms as other industries, trades and services to ensure an efficient use of resources, and environmental goals and landscape values should be secured using cost efficient regulation.

The three main goals of the recommendations in the first chapter of the Report are:

- To improve agricultural productivity
- To ensure that environmental goals are met cost efficiently
- To ensure an economically sustainable agricultural sector

These goals should be met by:

- Removal of a range of restrictions in Danish agricultural law
- Regulation of agricultural emissions of greenhouse gases
- Focused and cost efficient regulation of fertilizers and pesticides
- Avoiding crisis aid to the agricultural sector
- A renewed effort to phase out agricultural support from the EU

A historic perspective on Danish agriculture

World market prices of agricultural products have been decreasing over the last 50 years in real terms. This tendency has also occurred in Denmark, where real prices of agricultural products fell by nearly 90 per cent from 1966 to 2007. The decreasing prices had been counterbalanced by growth in productivity, which was consistently higher than productivity growth in other sectors over the same period. The average annual growth in agricultural total factor productivity (TFP) was 5.4 per cent during the period 1966 to 1989. The economy-wide annual growth in TFP was 1.7 per cent during the same period. Since the mid 1990s,

however, the growth in agricultural productivity has been rapidly decreasing and has even been negative in the most recent years.

Real prices of agricultural land have been increasing rapidly since the mid 1990s. Real capital gains were 250 per cent from 1993 to 2008. These significant capital gains have meant that total returns from agricultural investments have been above market interest rates, despite the weakening trends in profits from agricultural production during the same period. The weakening trend in profits is the result of decreasing growth in productivity and decreasing prices, especially of animal products.

The OECD expects that world market prices of agricultural products will continue to decrease in the years to come. Analyses in the Report indicate, however, that despite the falling price trends, Danish agricultural production could be maintained if the historically high growth in productivity is restored – an assumption that is somewhat uncertain given the current decrease in agricultural productivity growth.

Periods of low growth in productivity are seen in most economic sectors. This is not necessarily a problem if it is temporary or if the sector is only exposed to limited international competition. However, the negative trend in Danish agricultural productivity has lasted a decade and international competition is strong. What's more, world market prices of agricultural products are expected to continue to decrease. Thus, it would seem that Danish agriculture is facing a structural problem with continued low profit margins. The problem is magnified by the fact that debt in the sector has grown faster than profits in recent years. Hence, some agricultural businesses may face negative profits after the payment of financial costs in the coming years.

Historically, the real growth in agricultural property prices has followed similar trends to the real growth in residential prices. However, real agricultural property prices have continued to increase in recent years, while residential prices have been decreasing. This is the result of agriculture-specific factors such as the changes in EU agricultural

support, which partly decouples the level support from the level of production (in the following referred to as Common Agricultural Policy [CAP]). The recent global food crisis may also have created an expectation of permanently higher food prices, especially crop prices. The decline in the Danish housing market since 2007 and the lack of any likely major improvements in the agricultural prices, which could have led to further capitalisation in land prices, mean that the large capital gains seen in recent years have now come to an end and, in some cases, have even been replaced by real capital losses. This creates, in combination with the weak agricultural profits and the increased capital costs in the most recent years, a risk that parts of the agricultural sectors may have become unprofitable. This is a structural problem and necessitates an increase in profits through increased productivity growth.

Productivity and environmental concerns

The negative development of agricultural productivity is partly caused by the significant capital gains, which have made it possible for less efficient farmers to continue to operate. The necessary structural development has, therefore, been too slow. Whether the low growth in productivity will continue or whether the sector will be capable of returning to the historic trend of high growth is uncertain. However, analyses indicate that scale effects exist in agricultural production and a development towards larger farms is, therefore, from a purely economic perspective, beneficial. The Danish agricultural law includes several elements that limit the growth in farm size. It is recommended that all these limitations, especially concerning ownership regulation, be removed. The recent "Green Growth" policy initiative by the Danish Government proposes the removal of some of these restrictions, but also allows some restrictions to remain, which could potentially have a negative impact on future productivity growth.

The impact of "Green Growth" on agricultural productivity is analysed in the Report. Analyses show that there would be an increase in greenhouse gas emission and a negative impact on the environment from increased productivity

growth, due to increased production. It is, however, erroneous to limit agricultural productivity growth because of environmental concerns. High growth in productivity is generally desirable as it brings wealth to society. However, there should be an increased focus on the environmental and climate targets and on ensuring that natural habitats and landscape values are not damaged as a result of easing the restrictions in the agricultural law.

The Danish agricultural crisis

Up until 2008, the return from owning and operating farms was high compared with market interest rates. This was mainly due to significant real capital gains. Therefore, the lack of prospects for future real capital gains and the prospect of possible capital losses may result in a crisis in Danish agriculture as the returns on net capital are close to zero, when real capital gains are not taken into account. Expected increasing interest rates and a tendency towards real capital losses creates a risk that some farmers will be technically insolvent and others will be solvent but unable to cover interest payments and, therefore, be threatened by bankruptcy. This indicates, in combination with the weak development in productivity over the last decade, that Danish agriculture is facing long term structural problems and not just a few bad years.

The 2005 reform of the CAP towards decoupled support has, as expected, contributed to the significant increases in the real prices of agricultural property. The expected reductions in agricultural production and investments resulting from the reforms have, however, not occurred. Investments, primarily in land, have increased rapidly, which has led to increased debt and, therefore, increased capital costs. This is noteworthy, as agricultural profits were already low before the reform, which would have suggested a decreased production rather than increased investments as a result of the reform.

Analyses show that nominal profits have been decreasing slightly over the period 1990 to 2007 for all farms except cattle farms. All types of farming have increased debt and,

thereby, increased capital costs. It seems that farmers have increased farm size in order to achieve positive scale effects to gain improved profitability. However, the required improvements in efficiency are substantial, as the investments were made in a situation of very high land prices. This implies that some of these investments may be unprofitable if interest rates increase.

Agricultural crisis aid not recommended

Low growth in productivity combined with an expected decline in world market prices of agricultural products indicates that negative farm profits are not a temporary problem rather the problem seems to be long term. The prospect of constant or even decreasing land prices underlines the lack of profitability in the sector, which could lead to solvency problems for a series of farms. In this situation, agricultural crisis aid could easily enable both efficient and less efficient farmers to continue operating for a longer period, which just postpones the necessary structural adjustments in the sector.

Danish agriculture has been supported for many years, both directly through the CAP, and indirectly through national support in the form of reduced taxes on land used for agricultural purposes. Direct EU support together with the indirect Danish support totals DKK 1,700 per capita annually. Crisis aid granted as even lower taxation of land would be harmful, as it would be capitalised in land prices. It would, therefore, lead to real capital gains on land, which would enable farms with low profitability to continue production. Farmers who are efficient and want to extend their businesses will face higher land prices. If the lower land taxes from crisis aid are fully capitalised, the increase in land prices would be as high as the total discounted value of the future gains from the lower taxation of land. New farmers, would, therefore, not get any advantage from the lower taxation of land, and the public budget would be bound to permanent, unnecessary and erroneous expenses.

National crisis aid that is announced as temporary and that is characterized as a one-off affair (e.g. temporarily eased

taxes, temporary postponements of payments of VAT or temporary income aid) is less damaging. There is no direct effect on land prices and there would be no permanent costs to the public budget. Whether one-off temporary crisis aid should be granted is, to some extent, a distributional matter. Seen from an economic perspective there are several problems connected to temporary crisis aid. Primarily, temporary crisis aid creates an expectation that the government will also intervene during the next crisis. This can lead to farmers taking higher risks and not being sufficiently consolidated to handle future crises themselves. Furthermore, this may lead to increases in land prices even when the crisis aid is temporary.

Without crisis aid, the number of bankruptcies in the sector is likely to increase unless the farmers are able to restructure their debts in order to manage the excessive debt in some farms. However, such an agreement to reduce debt is primarily a matter between the creditor (the bank) and the farmer. Hence there is no need for public intervention. A high number of bankruptcies in the agricultural sector may create problems for some minor Danish banks. This problem should be targeted using initiatives in the financial sector and is not an argument for agricultural crisis aid.

A proportion of farmers are facing the risk of being technically insolvent if the real price of agricultural land decreases. This is not necessarily a result of low profitability, but can be caused by unfortunate financial choices, such as purchasing land at too high prices. Farmers who are efficient but have been unfortunate should, in the long term, be able to manage the solvency problems themselves by operating with a surplus. Such farmers should be able to stay in business without public crisis aid.

Phasing-out EU agricultural support

The agricultural sector should operate on the same terms as other sectors to ensure the efficient use of resources in the economy. Hence, permanent support should be phased out. This implies that the CAP should be phased out to enable an agricultural sector that is economically sustainable and

independent of public support in the long term. Phasing out the CAP is not a national decision, but Denmark should, as an EU member state, work towards policy reforms to abolish support. Denmark's contributions to the EU agricultural programme correspond to DKK 1,300 annually per capita.

The CAP has been through several reforms over recent decades. Direct support of agricultural production generally leads to inefficient use of resources as production decisions are affected and this has led to overproduction in the past. The 2005 reform that tries to decouple agricultural support from production of agricultural products is, therefore, a step in the right direction, as the support is now less tied to specific production and is, therefore, less distortionary. The main purpose of the CAP is to increase farmers' income. The reform has, however, contributed to increasing land prices and, therefore, to capital gains to the existing farmers. The capital gain depends on the part of future support that is not related to production after the reform. Therefore, future purchasers of agricultural land will face increased costs of purchasing land that correspond to this capital gain. Thus, decoupled support may not improve the situation for future farmers. The farmers who owned the land at the time of the reform in 2005 receive the main benefits from the reform. In total, an average full time employed farmer has achieved capital gains of DKK 11 million from the year 2000 to 2008 (in DKK 2005 prices). The EU reform has contributed to this substantial capital gain.

Phasing out the CAP will mean that the efficient part of the sector can purchase agricultural land at reduced prices as the market adapts to the new situation without support. New farmers who want to purchase a farm will, therefore, not suffer any economic losses as a result of removing the support. The lower land prices will also make it cheaper to buy land for alternative uses, e.g. national parks or other recreational uses. This will neutralize the existing distortion, where too much land is used for agricultural purposes, all things being equal.

However, as the support is not completely decoupled from the level of production, too many resources are still used in

agricultural production and phasing out the support will also lead to less distortion. The economic resources that have been going to support agriculture could, alternatively, have been used to reduce public budgetary deficits or to reduce income taxes to increase the supply of labour. Analyses in the Report show that phasing out the support would also decrease Danish agricultural production. As the CAP leads to a higher level of production compared to a free market situation, it also creates increased environmental stress. However, phasing out the CAP is not an optimal instrument for reducing environmental stress as such a goal should be handled with instruments targeted specifically to that purpose.

The extent to which existing farmers should be compensated when phasing out support is a political decision. An immediate termination without compensation would reduce government expenditures to the support scheme quickly, but the capital loss for the farmers would be equally large. With full compensation, or by phasing out subsidies very slowly, government expenditure would not be reduced as much, but capital losses for farmers would be proportionally smaller. There are several solutions for compensating land owners and it is a political decision to choose between them.

To reduce the effects on farmers, *bond schemes* are an alternative when phasing out support. In such a scheme support is coupled to the landowner instead of to the land. The payments under a bond scheme would fall away when existing land owners pass away. This ensures that existing land owners can keep their land and continue to produce within their lifetime. To accelerate the development towards a more productive sector, it is recommended that the value of the expected support payments is paid when the farmer sells his land. In principle, a solution using bond schemes could be carried out so that existing land owners would get full compensation for their capital loss. This would not reduce government expenditure in the short run, but the whole economy would benefit when the distorting support is phased out.

If it is not a political option to completely phase out the CAP, Denmark should use the existing support optimally. This should be done by making use of the possibility of reallocating 30 percent of support to environmental purposes, thereby helping to reduce the environmental impact of agricultural production.

Indirect agricultural support

Danish agriculture receives national indirect support via lower land taxes on agricultural land. This support amounts to DKK 400 per capita annually, which could be used differently, e.g., to improve public budget deficits or reduce income tax. However, the possibility of phasing out the indirect support may be limited by distributional considerations.

As opposed to the CAP, the Danish indirect support to agriculture does not distort production, as it is based on ownership of land. Neither does it lead to distortion of land use between urban and agricultural use, since this distribution is regulated through land planning laws. It could, in principle, lead to distortion between agricultural land use and other usage of land (e.g. National parks), however, it is difficult to assess whether this is the case in practice.

This means, that the distortionary effects of the indirect support are difficult to assess. Even though the indirect support can not be characterised as distorting, it should not have been introduced, since it has led to wealth redistribution to agricultural land owners from all other citizens. What's more, the support has been capitalised and, therefore, has resulted in higher land prices. This resulted in capital gains at the time the support was introduced and could now result in problems for the land owners if the support is phased out again, as it could result in capital losses. This is a problem when the land has changed hands in the mean time, since the current owners have paid too much for their land. However, the degree of capitalisation depends on expectations of future support, since there is no guarantee that the support will last forever. This risk is reflected in the land prices. Furthermore, most existing land

owners have recently experienced considerable capital gains because of the rising land prices. The argument that existing land owners have paid too high a price because of the capitalized support is therefore less important.

However, the support has permanently been a burden on public funds, which could have been used differently. Despite this, it is not obvious that support should be abolished due to distributional effects. To the extent that support is not fully capitalized in land prices, or that the capitalized value has been inherited by descendents, there is no objection to a limitation of the tax break from a distributional point of view. At the same time new support for farmers should not be introduced. Any new support would risk putting a permanent burden on public funds without any certainty that future farmers would be better off. As a matter of fact future farmers would suffer a loss if the support is capitalized in land prices and the support is then abolished again at a later stage.

Achieving GHG reductions cost effectively

Agricultural production is greenhouse gas (GHG) intensive. Within the existing climate policies, agriculture is not obliged to reduce climate gases as much as would be optimal from a socioeconomic point of view. Thus, there is a risk that other sectors (e.g. transport and households) are burdened with unnecessarily large costs, or alternatively the climate targets will not be reached.

Denmark is obliged to reduce its greenhouse gas emissions from the sectors that are outside the Emission Trading System (the non-ETS sector), which agriculture is a part of. It is a Danish objective that the non-ETS sector is to reduce its emissions by 20 percent over the period 2005 to 2020. Previous analyses have indicated that this target will result in higher costs than is the case for sectors within the ETS. Denmark should try to offset this by buying non-ETS emission rights from other EU countries. In return, an emissions tax corresponding to the expected quota price should be imposed on the non-ETS sector in order to equalise the costs between sectors.

A large proportion of the GHG emissions from agriculture is due to emissions of methane and nitrous oxide. These emissions should also be subject to GHG taxes. This would ensure that GHG reductions are obtained in the most cost effective way. Analyses in the Report show that if such a tax were imposed on agricultural GHG, emissions would be reduced by 2 percent, mainly as a consequence of lower agricultural production. However, it is assessed that the long-term effects are underestimated due to the method used to calculate the emissions. Despite this the analysis shows reductions from this source are limited and that phasing out the CAP would be expected to lead to much bigger reductions in GHG emissions.

It has been noted that agriculture is faced with considerable leakage problems regarding countries both inside and outside the EU. However, if Denmark buys non-ETS emission rights internationally and emission reduction targets for agriculture in all other EU countries are similar to the Danish target, there will be no leakage problem in relation to other EU countries.

In relation to countries outside the EU, there will be some degree of leakage. However, this is also a problem for other industries both inside and outside the ETS sector. There is no economic argument why agriculture should face lower marginal reduction costs than other sectors. On the contrary, if agriculture is exempt from reduction demands, other sectors will have to reduce more and thus be burdened with inappropriately large costs and a potentially enlarged leakage problem.

Environmental effects of nutrients and pesticides

The agricultural sector affects the environment in several ways. The use of fertiliser and animal manure leads to nutrients leaching into aquatic environments, such as lakes and coastal areas. The use of pesticides harms biodiversity both in the fields and the surrounding natural areas. In addition, agriculture affects the countryside substantially. In some areas improvements have been made, e.g. as a consequence of regulation, but the need for increased future

regulation depends, to a high degree, on developments in agricultural production.

The recent government policy plan "Green Growth" contains several initiatives to improve both the environment and productivity in agriculture. In addition to these initiatives, we suggest the following regulations of the environmental impacts from agriculture:

- A national tax or tradable quota on nitrogen instead of the existing farm specific nitrogen quota system
- Additional local initiatives targeting leaching of nitrogen to surface and ground water as well as pesticide free buffer zones along field margins

"Green Growth" also includes initiatives to change the regulation of pesticide use. Effective regulation depends on whether the environmental effects of pesticides are known and whether initiatives are targeting the desired changes in these environmental effects. In the regulation of pesticides there is generally a lack of knowledge about the actual environmental effects. In "Green Growth" it is suggested that the tax on different pesticides should depend on the environmental effects of the pesticides. However, as long as the true environmental effects of pesticides are unknown, tax changes may not lead to the desired reductions in environmental effects from pesticides. Thus, it is necessary to use other instruments to reach the targets for reduced environmental effects of pesticide use. Reduced impacts on biodiversity could instead be achieved using initiatives targeting specific areas, e.g. pesticide-free buffer zones. This is a cost effective initiative, which should be implemented.

The negative environmental effects of nitrogen leaching into the waterways are currently high. "Green Growth" aims to reduce the amount of nitrogen leaching to the aquatic environment by 19,000 tonnes per year before 2020. Policy instruments to achieve half of this reduction (9,000 tonnes) are described in "Green Growth" in detail and come from area-specific, local initiatives, e.g. wetlands, catch crops and buffer zones. The remaining reduction (10,000 tonnes) is to

be achieved by changing the existing general regulation of nitrogen use.

"Green Growth" suggests using regional or locally transferable nitrogen quotas instead of the existing regulations. This is basically a good idea since environmental sensitivity to nitrogen leaching varies greatly across different areas. Thus, objectives should be set locally. However, there are substantial problems with controlling a locally differentiated transferable quota system, because nitrogen can be easily transported between areas and because it is not possible to observe and control nitrogen supply to specific fields. Such a system is, therefore, difficult to implement and monitor.

Alternatively, a non-local quota system could be used, e.g. a national quota system or a tightening of the existing crop-specific nitrogen standards. However, this would also create substantial problems. First of all, it would require high reductions in general fertiliser application and thus have large costs for farmers. A simple calculation shows that a reduction in nitrogen supply of around 40-50 percent is needed to reach the national target of 10,000 tonnes less nitrogen. Thus, the idea in "Green Growth" that a big part of the nitrogen reduction will come from changing the general regulations seems to be unrealistic.

Instead, local, area-specific initiatives should be used to a greater extent. The Chairmanship suggests implementing a combination of voluntary measures to reduce nitrogen leaching and a cultivation tax, which is imposed if the objectives are not achieved in environmentally sensitive areas, see also Economy and Environment 2009. This mechanism takes into account both the local variation in environmental effects and the problem of control. The mechanism can be used in combination with many of the local initiatives in "Green Growth", e.g., establishing new wetlands.

It will be a big challenge to achieve the target of reducing nitrogen leaching to the aquatic environment by 19,000 tonnes. Therefore, it will be necessary to cease production on large areas of environmentally sensitive agricultural

land. Alternatively, very high costs will be imposed on agriculture to achieve the objective. Permanent land retirement would have unequal distribution effects among farmers and thus compensation should be given to the effected farmers, e.g., within the framework of "Green Growth". Additional funding could possibly come from the CAP as the EU recently has allowed for a proportion of the direct support to be targeted to environmental purposes.

The need for public funding would increase if there is an additional use of subsidy-based local initiatives. This can be solved by increasing the transfer from the CAP to environmental purposes under the Rural Development policy within the EU. Since environmental-related support under this program is partly nationally financed, this will affect the government budget. Alternatively costs may be imposed on agriculture.

When implementing environmental regulations, in general, the Polluter Pays Principle is used in most industries. This is not the case for agriculture. On the contrary, agriculture is often paid to reduce its environmental impact. It is recommended that the polluter pays principle should be applied to Danish agriculture to a larger extent in future regulation. The exemption of agriculture from this principle corresponds to resources being transferred from owners in other sectors to agriculture, without being grounded in efficiency improvements or distributional effects. That is, that the polluter pays principle does not apply to agriculture has the character of random redistribution. Compensation can be an option though, when environmental regulation has the character of expropriation.

Chapter 2: Recreational amenities in towns and in the countryside

Nature and recreational opportunities can be found not only in forests, at the beach or in nature reserves, but are ubiquitous in the landscape both in the countryside and as green spaces in cities. This is partly a consequence of the multifunctionality of the landscape, according to which land with a given use can fulfil various functions at the same time. A nature reserve can, for instance, preserve species, while simultaneously offering recreational opportunities. An agricultural landscape generates produce but may also present aesthetic values for visitors.

These kinds of recreational amenities are characterised by non-rivalry, as their use by one person does not prevent another person from enjoying them. The welfare economic costs of providing the amenity to an additional person are thus zero, and the good ought to be provided free of charge. A private supply of recreational amenities to match demand is therefore unattainable. As a consequence, public provision is necessary, either by regulation of land use or access rights, by nature preservation, or by explicit public ownership of land.

Due to the lack of markets for many recreational amenities, recreational values are rarely included in the decision making process for land use by private owners. Their monetary value can, however, be included when drafting new regulation or projects through the use of regulatory impact assessments and cost-benefit analyses based on valuation studies. An increased use of such measures can build on the experience gained using environmental impact assessments and guidelines for similar procedures in a number of OECD-countries.

For smaller projects a full cost-benefit analysis may be too costly as the monetary assessment of non-market goods for such analyses requires explicit valuation studies. In these cases, the use of benefit transfer techniques or of a “decision tree” can be considered. Benefit transfer techniques utilise the unit values of environmental amenities from

existing valuation studies of comparable goods. The "decision tree" is a sequential approach. In the first step a net benefit measure of the project is calculated based on easily assessable values, typically of marketed goods. A project with expected positive non-valued environmental effects is implemented if this first-step net benefit is positive *or* the non-valued effects are considered to surpass a negative first-step net benefit measure. A project, where the (non-monetary) effects on the environment, recreational goods etc. are considered to be negative, is implemented if the first-step monetary net benefit is positive *and* the non-monetary effects are regarded as being smaller than the monetary net benefit from the first step.

The evaluation of non-market recreational values is exemplified through a hedonic valuation study for various types of recreational amenities in Greater Copenhagen. The analysis shows positive and diminishing marginal prices for the proximity to the recreational areas, with variations among the study sites and types of amenities valued. The analysis, however, also gives rise to a discussion of a number of factors that need to be taken into account for the valuation of environmental amenities, e.g. possible general equilibrium effects of changes in the supply of green spaces.

Recreational opportunities in the form of nature trails, beautiful scenery in the countryside or proximity to green spaces in urban areas are contingent on three factors; the existence of recreational amenities in the countryside or in urban areas, lawful access for the public to the areas and proximity to the population as a whole. The existence of a beautiful countryside is, therefore, not a sufficient condition for a recreational value. Public access rights and the location of recreational amenities in relation to major population clusters need to be taken into account.

Policies to increase the supply of recreational amenities should take into account that there are different types of recreational demands. Analyses show that recreation can take the form of short trips during the week or longer trips to more distant locations on weekends and during holidays. The use of recreational amenities during the week often

involves exercise, whereas trips on weekends and during holidays often have a longer duration and focus more on particular experiences as well as spending time with friends and relatives. Controlling for a range of other personal characteristics, an analysis also shows a slight positive dependence of recreation on earned income. This result confirms the findings in the international literature.

Public provision of recreational amenities should take into account the type of recreational amenity and the size and geographical distribution of its user group. The entity ensuring provision of an amenity should be able to internalize the derived non-market benefits from the amenity in question. When a recreational amenity is used by a small, limited group of people, an agreement between the supplier of the amenity and the users can be negotiated without the involvement of public authorities. If an amenity is used by the population of a municipality, the local authority can ensure provision of the amenity at a satisfactory level, either through purchase of access rights or through public ownership. This usually applies to recreational amenities used mainly for shorter trips during the week. A recreational amenity used by a wider group of people, however, should be ensured by a regional or national authority. Recreational amenities such as national parks belong in the latter group and their establishment should not be exclusively contingent on support from the local authority in the area.

The Danish policy on forestry employs a principle of compensation for the removal of forests in the form of a new forest in another location. The compensatory forest is usually required to exceed the size of the original forest, depending on, e.g., the age of the forest, its location with regard to population centres etc. This requirement is a compensation for the loss of utility incurred in the period before the new forest has reached a suitable state for recreational use. This principle of compensation ought to be extended to apply to other, widespread types of nature such as hedgerows or pastures. This could prevent a decline in the existing stock of different types of natural environments and insure against adverse effects from structural developments in the agricultural sector as farm size increases fol-

lowing liberalisation of Danish agricultural laws. At the same time, the principle of compensation is flexible so that land owners are able to adjust their production structure when it is needed, which may result in efficiency gains large enough to cover the cost of re-establishing, e.g., a hedgerow or pasture elsewhere.

There is a possible conflict between conservation and recreation, as the use of an amenity for recreation may impact unfavourably on, for instance, the wild life in the area. Such conflicts can be minimized by, e.g., establishing trails in the area to direct the recreational use to the least vulnerable parts, leaving other parts virtually untouched for conservation. In addition, an expansion of trail systems or the number of small roads can increase public access.

There are a number of different subsidy schemes in Denmark that aim to conserve nature. For the individual land owner it can be difficult to discern the most appropriate options among the alternatives. For this reason integrating the different schemes into a single programme with a uniform payment structure ought to be considered. In the United Kingdom the Environmental Stewardship Scheme presents an example. In this programme, a land owner faces different options such as hedgerow maintenance, buffer lands, establishment of trails etc. with each option yielding a number of points. The land owner is then compensated according to the total number of points accumulated for his property. Such a programme would increase the transparency of the existing Danish system and, through the points allocated to each option, make the implicit trade-offs between different options clearer.

As a part of the so-called “health check” of the European Union’s Common Agricultural Policy in 2005 a transfer of up to 20 per cent of the funds from direct payments to larger farms to the Rural Development policy was introduced (so-called “modulation”). The Rural Development policy subsidises, among other things, water management and biodiversity measures. It is recommended that the share of funds transferred be increased in order to expand the funding for environmentally friendly agricultural production. Such a

transfer allows subsidies for agriculture to go hand-in-hand with nature conservation.

Chapter 3: Energy consumption and greenhouse gases

Chapter III presents a projection for energy consumption and emissions of greenhouse gases in Denmark from 2009 to 2025, see table A. The projection is based on the DEMS model developed by the Danish Economic Councils. The projection forecasts an increase in final energy consumption for households, industries and transport of 0.3 per cent per year over the projection period. The increase in energy consumption can primarily be explained by an increase in petrol and diesel consumption for road transport. Although energy consumption has decreased, due to the current economic crisis, final energy consumption is expected to be 35 PJ larger in 2025 than the 2008 level of around 650 PJ. In contrast, the latest projection by the Danish Energy Agency from April 2009 shows an expected decrease in final energy consumption of approximately 10 PJ. The main reason for this difference is that the Danish Energy Agency assumptions about future energy efficiency (e.g. energy consumption per square metre or petrol used per car) are more optimistic than the projection in the Report.

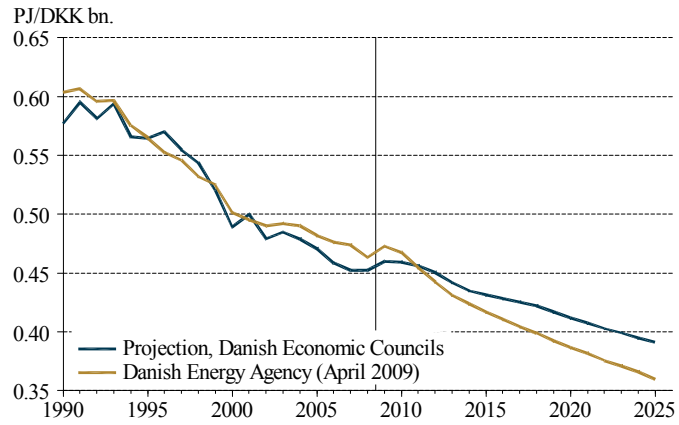
Tabel A Main results in the projection

	1990	2005	2008	2020	2025
	----------		2008-prices		----------
Oil price ($/barrel)	34	58	97	104	109
Price of electricity incl. tax (DKK/kWh)	1.55	1.89	2.04	2.07	2.07
	----------		PJ		----------
Gross energy consumption	782	807	824	800	825
Final energy consumption	578	648	649	666	685
	----------		Per cent		----------
Renewable energy, share of energy consumption	5.0	14.5	16.2	32.4	31.8
	----------		Mill. tonne		----------
Emissions of greenhouse gas	69.4	64.3	64.4	53.1	53.3
Non-ETS sector	39.4	37.8	37.8	36.2	36.9

Source: Statistics Denmark, Ecowin and own estimates.

The projection indicates that final energy consumption will continue to increase with a lower rate than GDP. Compared to the Danish Energy Agency, the partial decoupling of energy consumption and economic growth is smaller, see figure A.

Figure A Final energy consumption relative to GDP



Note: Historic differences arise because of different definitions.

Source: Danish Energy Agency, Statistics Denmark and own estimates.

In terms of central objectives in Danish climate and energy policy, the projection finds the following results:

- One target is to reduce gross energy consumption by 4 per cent by 2020 relative to 2006. The projection indicates that this target will just be reached. After 2020 gross energy consumption will increase again due to higher economic growth
- The Kyoto Treaty obliges Denmark to reduce the emission of greenhouse gas by 21 per cent, on average, during the period of 2008-12 relative to emissions in 1990. The Danish National Allocation Plan describes how Denmark will comply with the targets. This projection indicates that the Allocation Plan can be achieved
- Denmark must reduce emissions of greenhouse gases from the sectors of the economy that are not covered by the Emission Trading System (the non-ETS sector) by 20 per cent by 2020 relative to 2005. Part of the annual reduction can be achieved by purchasing emission rights in other EU-member states and by purchasing credits outside the EU. The projection indicates that emissions from the non-ETS sector will only be reduced by 4 per cent,

leaving a reduction-deficit of approximately 6 million tonnes of CO_2 equivalents in 2020
- The share of renewable energy out of total consumption should be 30 per cent by 2020. The target is expected to be realised with the current subsidies

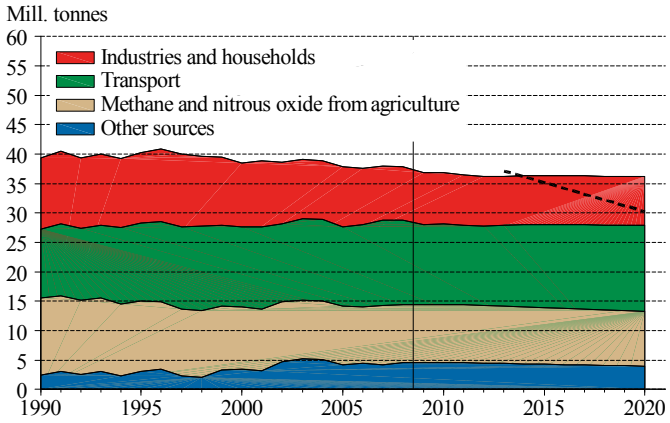
The objective for renewable energy is part of the EU energy policy but it is hard to justify a national target for renewable energy. Renewable energy can reduce greenhouse gas emissions, but if the primary goal is less impact on climate, the ideal instrument is to increase the price on CO_2 through taxes or quotas. A high and fairly stable emission price will, in itself, provide an incentive to switch to renewable energy and develop new technologies. If quotas and taxes can ensure a high and fairly stable price there will be no need for subsidising renewable energy. As noted, the target for renewable energy is expected to be realised. This result, however, is very dependent on the assumptions about the CO_2 quota price, energy prices and the subsidies for renewable energy. For example, if subsidies for renewable energy are reduced by 0.05 DKK per kWh, the target for renewable energy will probably not be reached. This illustrates that relatively small changes in the assumptions can affect the results.

It is also hard to justify the national reduction targets for gross energy consumption. Lower energy use can reduce greenhouse gas emissions, but if the primary goal is a smaller impact on climate change, greenhouse gas emissions should be influenced directly (i.e. by reducing the use of fossil fuels). If the main goal is to improve security of supply, one should focus on the forms of energy that are of concern (i.e. oil and gas) and not on relatively safe energy sources (e.g. turbines and coal). This could, for example, be implemented by taxing the types of energy where energy supply is a political concern.

The central objective of Danish climate and energy policy is to reduce emissions from the sectors that are not covered by the EU ETS system. The non-ETS sectors include mainly agriculture, transport, non-energy intensive industries and household energy consumption for individual heating. The

projection indicates that the emissions of greenhouse gases from the non-ETS sector are only expected to fall from approximately 38 million tonnes in 2005 to about 37 million tonnes by 2020. In terms of the requirement of a 20 per cent reduction by 2020 relative to 2005, this implies a reduction-deficit of approximately 6 million tonnes, see figure B.

Figure B *Greenhouse gas emission from the non-ETS sector*



Note: Greenhouse gas emissions are measured in CO_2 equivalents. The dashed line shows the required adjustment path if all reductions are made domestically.

Source: Statistics Denmark, National Environmental Research Institute/ Aarhus University and own estimates.

To minimize costs of a given climate policy, all countries and all sectors should face the same price on greenhouse gases. All industries in the EU ETS system have the same price for CO_2 – the quota price. A uniform price for all emissions also requires charging for methane and nitrous oxide emissions from agriculture. Calculations in the Report indicate that the reduction-deficit will be reduced by approximately ¼ million tonnes to approximately 5¾ million tonnes. A uniform tax on all emissions that is in line with the expected quota price will ensure a cost effective reduction, but the reductions will fall far short of the target.

An obvious opportunity to meet reduction requirements in the non-ETS sector is to allow EU member states to buy quotas from the ETS sector. This would tend to increase the quota price and imply larger reductions in the quota sector. Reduction requests for the non-ETS sector will be reduced and the marginal abatement costs will fall. Allowing quota acquisitions would offset marginal abatement costs between countries and between sectors implying that the climate targets would be achieved in the least expensive way. Unfortunately, the EU does not allow this opportunity.

In the absence of this opportunity Denmark should – as far as possible – realize their reduction requirements by buying emission rights in other EU member states where marginal abatement cost for greenhouse gases are small. Abatement costs will be lower in most EU-countries, partly because of lower reduction requirements than in Denmark. By trading emission rights, these cost differences can be offset and trade will be an advantage to both those countries that achieve their targets by buying emission rights and for countries that already fulfil their reduction requirements nationally and can sell their surplus of emission rights. Denmark can also choose to purchase credits through CDM projects in countries outside the EU.

If for policy reasons reductions in the non-ETS sector must, to a greater extent, take place domestically, this should initially be done by increasing the overall tax on greenhouse gas emissions. Calculations shows that an increase in the tax on CO_2 from the expected level of 225 DKK per tonne to 500 DKK per tonne would reduce the deficit to approximately 5 million tonnes, even if non-energy related emissions from agriculture are charged the same tax. An increase in the uniform tax to 1,000 DKK will reduce the deficit to approximately 3½ million tonnes. Although there is considerable uncertainty related to these calculations, it seems clear that the tax must be very high if the entire reduction in the non-ETS sector has to be made domestically.

The need for a high tax in the non-ETS sector stresses the appropriateness of being able to buy quotas from the ETS sector, where abatement costs are much smaller than in the

non-ETS sector. Purchasing quotas to cover the reduction-deficit of 6 million tonnes for an expected quota price of 225 DKK will cost around 1½ billion DKK. This is far less than revenue from taxes on greenhouse gas emissions in the non-ETS sector can bring.

A very high tax on greenhouse gas emissions can have undesirable consequences on the terms of trade and income distribution. These undesirable effects can, in principle, be counteracted by compensating measures, e.g., differentiating the tax by income groups or increasing the "green cheque" (an income dependent compensation for higher taxes on energy). Alternatively, relatively high taxes can be combined with a subsidy to energy saving purposes or to renewable energy sources. Measures that encourage energy consumption to shift from the non-ETS sector to the ETS sector can also be a way of avoiding very high taxes, see the report last year on *Economy and Environment, 2009*. However, it is not straightforward to implement instruments that replace or compensate for high taxes. An income dependent "green cheque" would, for example, raise the marginal tax on income. The disadvantages of using subsidies instead of taxes are, in particular, that subsidies in practice often favour specific types of technology. Measures should not favour one technology over another, unless it is very well justified by imperfections or barriers, for example, in terms of public regulation in other areas. There are no reasons to believe that politicians, in general, are better at "picking winners" than the market is.

Chapter 4: International Climate Policy

According to the Copenhagen Accord global warming should be limited to a maximum of two degrees Celsius. This implies that a limitation has been put on the amount of greenhouse gases that can be emitted over the next decades. It is a tremendous challenge for the world to limit the emissions of greenhouse gases in order to reach the goal. The reductions need to be large and commence quickly.

The precise relationship between emissions of greenhouse gases, the concentration of greenhouse gases in the atmosphere and the future climatic conditions is very uncertain. A special type of uncertainty relates to the risk that extensive and perhaps catastrophic changes in the global climate can take place if the temperature exceeds an unknown threshold value. The decision to limit the increase in global temperature to a maximum of two degrees can be seen as an attempt to address this risk.

The global climate is affected by the concentration of greenhouse gases in the atmosphere. This concentration is, among other things, affected by anthropogenic emissions of greenhouse gases, which, in large part, are the result of burning fossil fuels. If the increase in global temperature is to be limited to two degrees, the use of fossil fuels must be reduced. It is quite certain that the amount of fossil fuel that can be burned without violating the goal of limiting global warming to two degrees is less than the world's known reserves of fossil fuel. If the Copenhagen Accord is to be taken seriously, a considerable amount of the world's reserves of fossil fuels must remain unexploited.

The special characteristics of the supply of fossil fuels create challenges for climate policy. First, there is a risk that poorly designed climate policies could give rise to larger emissions of greenhouse gases in the short run – or at least to smaller reductions than expected. This can happen because the producers of fossil fuels are able to speed up the extraction and sale of their resources if they fear stricter climate policy in the future. Second, the supply of fossil fuels is very inelastic. This means that a reduced demand for fossil fuels – for instance as a result of climate policy – will result in a lower price, which again will limit the effect of the policy, because the reduced price will tend to increase demand.

The Copenhagen Accord does not specify when the necessary reductions of greenhouse gas emissions should take place or how the effort should be distributed among countries. In the Kyoto Protocol a number of the world's developed countries (the so called annex I countries) committed

themselves to reducing greenhouse gas emissions. The less developed countries, however, did not commit themselves to any reductions in greenhouse gas emissions. In the 1990s emissions from the annex I countries made up a large proportion of the world's total emissions of greenhouse gases. However, since the Kyoto Protocol was agreed upon some of the countries, which did not committed themselves to reductions of greenhouse gases, have become responsible for a larger part of the world's total emissions. An example is China, where emissions of greenhouse gases have grown such that today China is the largest emitter of greenhouse gases. Furthermore, economic growth is expected to continue in China and the emission of greenhouse gases relative to GDP is high in China (about 8 times higher than in the EU and about 4 times higher than in the USA). Therefore, China must be a part of a climate agreement.

A stylised forecast of the global greenhouse gas emissions shows that emissions in 2050 could more than double. This result holds even if the historical trend of improved technology continues and the economic growth rates in less developed countries are assumed to decrease by about a half of the historical growth rates. The forecast also illustrates the necessary reductions of greenhouse gas emissions if total emissions over the period until 2050 are to be limited to an amount that is considered not to lead to an increase in global temperature larger than two degrees. If it is assumed that emissions will continue to rise until 2015, the required reduction of global greenhouse gas emissions for the period 2016-50 is about 1 percent annually. If the initial reduction of emissions is postponed until, for instance 2020, the required reduction in the period 2020-50 increases to 2.3 percent annually. For comparison, the EU's target of reducing emissions by 20 percent by 2020 compared to 1990 levels is similar to an annual reduction of 0.7 percent from 1990 to 2020. If the target gets tightened to 30 percent it is similar to an annual reduction of 1.2 percent. Thus, delaying action on reducing emissions of greenhouse gases makes it necessary to carry out larger reduction over a shorter time. This will increase costs and increase the risk of not reaching the goal of limiting the rise in global temperatures to a maximum of two degrees.

The reductions of global emissions, which are needed if the increase in global temperature should be limited to a maximum of two degrees, are so large that the developed countries are unable to make sufficient reductions alone. Therefore, the less developed countries also need to limit their emissions in the years to come. The stylised forecast shows that, even if the developed countries reduce their emissions to zero, the accumulated emissions from the less developed countries (the so called non-annex I countries) may exceed the maximum "allowable" amount for the period 2000-50 already by 2040.

Alternatively, if the CO_2-intensity (CO_2 emissions relative to GDP) in the non-annex I countries improves considerably relative to the historical trend, the required reductions of emissions in the annex I countries are large. If the CO_2-intensity in the non-annex I countries improves by 3 percent annually – relative to a historical trend of ½ percent annually – and it is assumed that growth rates in GDP in 2050 will fall to about half of the present level, then the required reductions in the emissions of CO_2 in the annex I countries is above 6½ percent annually, if reductions starts in 2011. Even though these calculations are based on stylised forecasts of historical trends, they highlight that a very large effort is needed from both developed and less developed countries if the goal of limiting global warming to two degrees is to be reached.

The negotiations at the COP15 meeting clearly showed that it is hard to get a global climate agreement. There are a number of reasons why it is hard to get all countries in the world to take part in a climate agreement. First, countries are affected differently by changes in climate and, thus, incentives for contributing to an agreement vary substantially. Second, relatively poor countries, which typically have lower emissions of greenhouse gases per capita than richer countries, will demand compensation in order to take part in a climate agreement. The compensation can, for instance, be smaller reduction requirements, technology transfer or other kinds of economic support. However, if some countries receive compensation or smaller reduction requirements, other countries have to pay for the compensa-

tion or reduce their emissions more. This reduces their incentive to take part in a climate agreement. Third, countries not contributing to the agreement will still benefit from the efforts of the countries joining the agreement. Finally, countries with large reserves of fossil fuels will lose expected profits. This is due to both smaller quantities sold and to lower prices. This gives such countries an incentive to work against a climate agreement.

For a number of reasons an agreement that does not include all countries is less effective. A reduction in the demand for fossil fuels in participating countries will, *ceteris paribus*, reduce the price of fossil fuels, which will lead to an increase in demand in the non-participating countries. This makes the reductions of world emissions of greenhouse gases smaller than the reductions made in the participating countries. Another problem that arises from a climate agreement that does not include all countries is the risk of leakage. Leakage arises if climate regulation in some countries makes industries move to countries not included in the agreement. This reduces greenhouse gas emissions in the countries with regulation. However, worldwide greenhouse gas emissions are not necessarily reduced. Since climate regulation is less restrictive in the countries where the industries relocate, leakage can increase worldwide emissions. Furthermore, the producers of fossil fuels may speed up extraction because they fear that a future climate agreement becomes world-wide, which would effectively limit their opportunities to sell fossil fuels in the future.

In practice, it is difficult to see how the world could arrive at an effective agreement that includes all countries. The negative consequences for some oil producing countries in the Middle East are so large that they probably do not want to be part of a climate agreement. What's more, countries such as the USA, Russia and China have large reserves of fossil fuels.

However, for an agreement to be effective it must effectively limit the extraction of the world's reserves of fossil fuel. Therefore, it must include the largest emitting countries. This includes not only the developed countries but

also large, less developed countries such as China and India. If a large group of countries is willing to join a climate agreement but the group is not large enough to make the agreement effective, it may be necessary to consider trade restrictions against countries that do not participate. Trade restrictions can reduce problems with leakage and counteract the weakening of the participating countries' competitive positions. At the same time, trade restrictions can create an incentive for countries to participate in a climate agreement. Imposing trade restrictions is obviously against free trade principles and, therefore, could only be justified under exceptional circumstances. If the climate goals are to be reached, however, trade restrictions may become a necessary instrument.

A system that effectively reduces emissions of greenhouse gases must be based on market based instruments such as tradable quotas or taxes. Such instruments ensure that emissions are reduced cost-efficiently by minimising the costs of reaching a given reduction of emissions. Further, this may increase the possibility that countries will join a climate agreement.

A quota or tax system can be designed such that quotas or taxes are paid either by producers or by consumers. In the existing systems such as the European Emission Trading Scheme, quotas are paid for by the users. If an agreement can be reached between all the major consuming countries, a system of quotas or taxes that are paid for by producers and importers of fossil fuels is likely to be simpler to administer and more effective because the number of producers and importers of fossil fuels is smaller than the number of users. Hereby parallel systems can be avoided.

Introduction of new technology is necessary if emissions of greenhouse gases are to be reduced as much as needed to limit global warming to a maximum of two degrees. Market-based regulation of greenhouse gas emissions (quotas or taxes) ensures a high and relatively stable price of greenhouse gas emissions, which promotes technological development. It is efficient to promote technological development through a price on greenhouse gas emissions because

it creates the same incentive for all types of climate-friendly technology. In order to create an incentive for the market to develop and implement new technology, a credible system that ensures a price on greenhouse gas emissions far into the future is needed.