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Encouraging Environmentally Sustainable Growth in Denmark

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ENCOURAGING ENVIRONMENTALLY SUSTAINABLE GROWTH IN DENMARK

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ABSTRACT/RÉSUMÉ

This paper analyses aspects of environmental policy in Denmark, including, among others, policy on surface water quality, clean air and support for renewable energy, waste disposal and transport policy. Environmental policies are an important priority in Denmark, with implementation often highly decentralised, but in some cases environmental objectives have been pursued at what seems a high price, perhaps through a wish to support the development of a domestic industry or to protect existing industry from loss of competitiveness. The paper criticises some of the arguments used in favour of this high cost approach in a number of contexts, including wind power subsidies, the carbon tax and the treatment of nutrient discharges from agriculture. The paper also discusses a number of innovative and efficient policies introduced or planned, for example the new approach to promoting renewable energy (including wind power) through tradable "green certificates" and a CO_2 trading scheme in electricity production. In some areas, such as policy for non-hazardous waste, apparent expansion of the role of economic instruments (through a series of differentiated taxes on disposal) seems to be dominated in practice by quantitative targets which may not provide the best outcomes.

JEL Classification: H23, Q00, Q20, Q28, Q40, Q48
Keywords: Denmark, sustainable development, environmental policy,

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Ce document analyse certains aspects de la politique de l'environnement au Danemark, dont, entre autres, la politique pour la qualité de l'eau et de l'air, le soutien à l'énergie renouvelable, le traitement des déchets et la politique des transports. La politique de l'environnement, souvent mise en œuvre à un niveau très décentralisé, est une priorité importante au Danemark. Néanmoins, dans certains cas, les objectifs environnementaux semblent avoir été poursuivis à un fort prix, peut-être afin de soutenir le développement de l'industrie nationale ou même pour protéger l'industrie d'une perte de compétitivité. Le document critique les arguments avancés en faveur de ces approches à coût élevé dans un certain nombre de domaine, en particulier les subventions à l'énergie éolienne, la taxe sur le carbone et le traitement des rejets d'éléments fertilisants de l'agriculture. Le document discute également un certain nombre de politiques innovantes et efficientes déjà mises en œuvre ou prévues, par exemple la nouvelle approche de la promotion des énergies renouvelables (y compris éolienne) au moyen "d'éco-certificats" échangeables et d'un système de permis échangeable pour les émissions de CO_2 dans le secteur de l'électricité. Dans certains domaines, comme celui des déchets non-toxiques, l'expansion apparente de l'utilisation d'instruments économiques (au moyen d'une série de taxes différenciée selon le type de traitement) semble dominée en pratique par des cibles quantitatives qui ne garantissent pas d'aboutir au meilleur résultat.

Classification JEL : H23, Q00, Q20, Q28, Q40, Q48.
Mots clés : Danemark, développement durable, politique environnementale.

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ENCOURAGING ENVIRONMENTALLY SUSTAINABLE GROWTH IN DENMARK[1]

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1. Introduction

1. Environmental issues have been high on the policy agenda in Denmark for some time. Although the Environmental Protection Act, the principal current piece of legislation, was introduced only in 1973, a Nature Conservation Act had already been introduced in 1917, and the Danish Society for the Conservation of Nature, a non-governmental organisation with an important role in implementation of environmental policy, dates from 1911. Even though Denmark is relatively highly urbanised – 80 per cent of the population live in urban areas – there are few very heavy concentrations of population, and there have never been significant concentrations of heavily polluting manufacturing or processing industry. Natural-resource-dependent activities are few but important: Denmark is currently broadly self-sufficient in oil and gas products from the North Sea; its fishing fleet is one of the world's largest; agriculture is perceived as one of the most important industries, though providing only some 3 per cent of GDP directly, it is also the base of an important food-processing industry. Nature-based leisure activities are also important to many Danes.

2. Although Danish emissions of certain air pollutants are relatively high – per capita emissions of NO_x and CO_2 ranked sixth and seventh in the OECD, respectively, in 1995 – air quality, insofar as it can be compared across countries, ranks better than this.[3] Most air pollution is in fact "imported" – over 80 per cent of acid deposition in Denmark of SO_x and NO_x comes from outside the country, while Denmark is a net exporter of such pollution – around 90 per cent of Danish emissions travel elsewhere.[4] Surface water quality, affected both by deposition from air pollution and direct discharges, is much poorer relative to other OECD countries, however.

3. The Economic Council has experimented with ways to represent the condition of the environment and natural resources in the national accounts. This is not done systematically, but an exercise in calculating real net saving showed that whereas the national accounts showed net saving over the period

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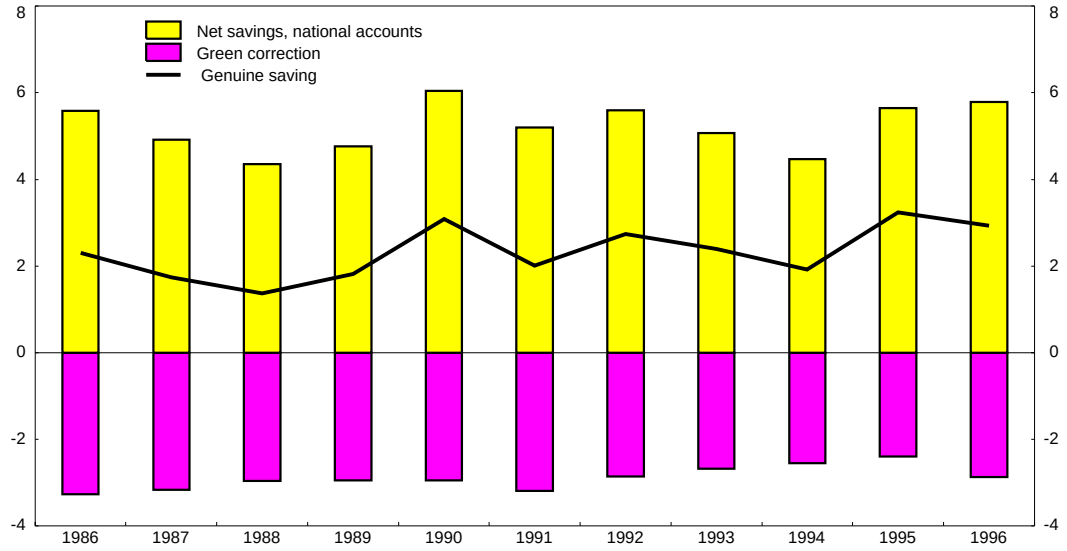
1 . This paper was originally produced for the OECD Economic Survey of Denmark, which was published in July 2000 under the authority of the Economic Development Review Committee. Working papers on the same subject have been published for Norway, Finland, Germany and the United States, and are forthcoming for a number of other countries.

2 . Paul O'Brien and Jens Høj are economists in the Economics Department of the OECD. The authors would like to thank Steen Daugaard and Ann Vourc'h for ideas and advice and Raoul Doquin de St Prieux, Dianne Scott, Lili Kee and Veronica Humi for their technical support.

3. By per capita SO_2 emissions in the mid-1990s Denmark ranked thirteenth. SO_2 emissions have fallen very rapidly over the last two decades, those of NO_2 much less so. Available cross-country data on air quality compares large cities only. See OECD(1999*b*).

4. See OECD (1999*a*), Environmental Performance Reviews: Denmark, Table 8.3, p.191.

Figure 1. "Green" adjustment to net national saving, 1986-1996
Per cent of NNP



Note. The "green correction" is the sum of the value of extraction of oil and gas,and estimated environmental cost of emissions of carbon dioxide, methane, nitrogen oxides, sulphur dioxide and volatile organic compounds (see footnote 5).
Source: Danish Economic Council.

1986-96 at around 5 per cent of net national product, a “green adjustment” reduced this by half (Figure 1). The green adjustment included corrections for depletion of oil and gas reserves, for emissions of greenhouse gases and other polluting gases,[5] but did not attempt to take account of water quality or even more difficult to value factors such as nature conservation or biodiversity. On this measure, environmental damage has a noticeable impact on welfare, with no clear trend over the period.

4. An active environmental policy is pursued, and in some cases, notably in respect of greenhouse gas abatement, ambitious targets have been set. A variety of different approaches to achieving the targets is used, varying from “command-and-control” regulation to taxes and charges (and, occasionally, both at the same time). This paper looks at a selection of issues: water, waste, energy and transport policies with their links to air pollution and greenhouse gas emissions; these touch on most (though not all) of the principal environmental issues in Denmark, and are the areas where the analysis presented here suggests that improvements could be made to policies. The focus is particularly on elements of policy which appear to be excessively costly, either through inappropriate instruments or where unequal treatment of different activities encourages inefficient responses. The paper opens with a brief outline of the policymaking institutions in the area of the environment; subsequent sections cover the policy targets and issues; a final

5. The full list of gases included, with their marginal costs (DKr per tonne), is: CO_2 (35.5), methane (702), N_2O (12 000), NO_x (13 100), SO_2 and volatile organic compounds (both 24 500).

section discusses the Danish approach to environmental targets and instruments, and to issues of balancing costs and benefits. Some conclusions and recommendations conclude the paper.

2. Institutions

5. Denmark is unusual in having a combined Ministry for the Environment and Energy.[6] It is argued that this allows better co-ordination between environmental and energy policies, which might otherwise be antagonistic. Co-ordination is clearly important, since so many environmental issues are linked with the energy industry. There is, however, a fine line between co-ordination and subordination, and care is needed to ensure that conflicts of interest are resolved as far as possible through systematic analysis.

6. Environmental targets and policies are decided centrally, but, in common with education and many social services, implementation of many aspects of environmental policies is delegated to municipalities or the regional ("county") level.[7] This includes in particular most issuance of operating or discharge permits, which are handled at county or municipality level depending on the size of the installation involved. Counties are also responsible for local and regional bus services, whose relation to environmental issues is discussed later. Municipalities are responsible for water supply and treatment and waste disposal, with a tendency for them to group together to provide these services as the necessary scale increases.

7. With a lot of responsibilities devolved to the local or regional level, the potential for democratic participation in many decisions is high,[8] but problems of lack of information or analytical capacity could emerge. The *Amtsrådsforeningen I Danmark* (Association of County Councils in Denmark) and the *Kommunernes Landsforening* (National Association of Local Authorities) provide a means for pooling such resources, as well as for joint negotiations with central government. In waste disposal there is less variation in approach than this decentralised structure might suggest; a national system of taxation is in place, allowing for internalisation of environmental costs in decentralised decision making, but centrally determined targets – not obligatory on local authorities – for different types of waste disposal appear to dominate local policy in practice.

8. The formal structure for integration of economic and environmental decision-making is well developed, although not unified, and its operation seems still to be evolving. Environmental Impact Assessments (EIAs) are made (under the 1992 Planning Act) in respect of various projects; responsibility for producing the EIAs lies in general with the county. Legislative proposals are subject to a requirement to produce a Strategic Environmental Assessment (SEA), which is based around a checklist of possible effects on the environment and which is the responsibility of the ministry sponsoring the legislation. Under a prime-ministerial decree, introduced in 1993 and revised in 1995 and 1998, the impact of environmental and other legislation on the economy must be assessed when it is presented to parliament. Although these arrangements provide a good framework for analysis of policy, the process is sometimes treated as a mere formality, with little independent checking of the accuracy of either the economic or environmental impact analysis – although the Finance Ministry will check any assessment of budgetary effects, it does not verify any wider impact analysis, nor does the Environment Ministry typically check the assessments of environmental consequences.

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6. For more details of institutions, see OECD (1999*c*).

7. There are 14 counties, excluding Copenhagen and Frederiksberg (which serve both municipal and county functions), and 275 municipalities in Denmark.

8. The procedure for deciding on whether bus services are socially useful was described informally to the Secretariat as to withdraw the service and then see how great the ensuing protest was.

9. Since 1997 a report ("An environmental assessment of the finance bill") has been prepared annually by the Finance Ministry. Criticised by some for being an economic assessment of environmental policy rather than the other way round, the reports are useful sources of information and explanation of many aspects of policy including, in some cases, information on costs and benefits.

10. A recent report into the efficacy of environmental assessments in the legislative process concluded, at least in respect of the two case studies undertaken for the report, that environmental impact assessments' influence on Parliament's decision to adopt legislation was "murky and vague" (Elling and Nielsen, 1998). The same report said that claims in the bills that they would bring beneficial environmental effects were not substantiated or explained.

11. Local or county administrative decisions can be contested on appeal to the Danish Environmental Protection Agency and subsequently, in certain cases or on matters of important principle, to an Environmental Appeals Board. A number of non-governmental organisations, notably the *Danmarks Naturfredningsforening* (Danish Society for the Conservation of Nature), act as watchdogs for the environment, and in certain cases have the right to make complaints. Appeals in relation to EIAs or land-use planning decisions are made to another body, the Nature Protection Board of Appeals.

12. Although the judicial system is rarely used, this array of centralised appeal bodies potentially provides a basis on which the consistency of the results of decentralised decision-making across the country is maintained. Information on whether such consistency is actually achieved is not readily available.

13. Finally, international agreements play an important role in Danish environmental policy. Two major sets of policy issues – emissions of greenhouse gas and of acid rain precursors – are almost entirely transboundary concerns. Steps that Denmark takes on its own to curb carbon or SO_x and NO_x emissions will give it very little direct environmental benefit, certainly rather little in relation to the costs incurred. But Denmark has every interest in playing a leading role in implementing such agreements, if this helps to encourage other "upwind" countries to cut their own emissions, thereby benefiting Denmark.

3. Policy targets and policy issues

14. The 1999 OECD Environmental Performance Review provides a comprehensive review of Danish environmental policies and targets. The aim of this paper is to assess a selection of these and their role in enhancing growth with environmental sustainability. Two specific environmental issues are taken up below: water pollution, which became an important issue during the 1980s when growing contamination by nutrients threatened Denmark's traditional reliance on largely untreated groundwater for its water supplies; and waste management, where central government policy aims to reduce use of landfills to very low levels, employing a range of reasonably sensible economic instruments but supplemented by inappropriate nation-wide centrally-determined targets. A number of different environmental issues are then treated under the headings of energy and transport policy, where the interaction of taxation, regulation and deregulation, industrial policy, international agreements and constraints, makes for a very complicated picture.

3.1 Water

15. Total water resources[9] per capita in Denmark, though adequate, are among the lowest in the OECD. Intensity of water use is nevertheless similar to a number of other OECD countries, because abstractions per head are relatively low (Figure 2); low water usage is partly due to the relative lack of

9. This is measured as precipitation less losses due to evaporation and transpiration from plants.

heavy industry, and the use of brackish or seawater for cooling in many power stations. Easy access to and previously high quality of groundwater supplies mean that Denmark is very unusual in that nearly all of its public water supply is from groundwater, in the past with very little treatment beyond simple filtering. However, surface and ground water quality had deteriorated substantially by the 1980s – in particular in terms of nutrient (nitrate and phosphate) concentrations (nitrates in ground and surface water, phosphates in surface water). As a result of this and the direct effects of surface water pollution, an ambitious plan for cleaning up surface water bodies was begun in 1987 and revised in 1998 as the Action Plan for the Aquatic Environment No. 2. Targets were set for different kinds of discharge and for different sectors – municipal water treatment plants, and industrial and agricultural discharges.

16. It is interesting that while municipal and industrial discharge targets have been met, at the cost of considerable investment and much higher water charges (see below), nitrate discharges from farms are well above target, even after the timetable for meeting it was relaxed. It is not clear whether the difference in response is due to much higher costs of reducing discharges on farms, which is a risk inherent in the kind of sectoral target quantity reduction approach often adopted in Denmark (the GHG reduction plans are another example of this), or whether it is that procedures intended to enforce reductions in fertiliser use in agriculture were not strong enough.

3.1.1 Water and agriculture

17. A logical response to continuing water quality problems due to discharges from agriculture would be to subject discharges from agriculture to the same rates that are applicable in the general tax on waste water, a tax levied on the nitrate, phosphate and organic content of waste water. There are a number of special conditions and exemptions to this tax, and agriculture is probably the most important single exemption.[10] A fertiliser tax was introduced, but it applies only to non-agricultural uses (of fertiliser).

18. A tax on the nutrient content of all fertiliser (and animal feed) could be very unpopular among farmers. Instead they are forbidden to use excessive amounts of nitrogen. They are subject to a fine per kilogram of "excess" fertiliser use, the fine being from two to four times higher than the tax. Excess use is defined farm by farm as a function of land use, a maximum allowed use of nitrogenous fertiliser and the actual use thereof. Farms are obliged to keep fertilisation accounts.[11] This is a system with rather poor incentive properties – farmers are penalised for excess use, but not rewarded for economising on fertiliser use below their assigned levels as they would be if a tax on all fertiliser were applied. Thus the incentive to develop innovative means of economising on fertiliser use is high – perhaps too high – when farms are in excess and too low where the legal limits are being respected. It is true that methods and timing of fertiliser application, as well as the use of catch crops, have an enormous impact on the amount of nutrients that escape into water bodies for any given amount of fertiliser use, so that even a fertiliser/feed tax would not be ideal. But a tax could be more efficient than the current approach, lowering overall compliance costs, for any given targets, by giving incentives for those with lower abatement costs to reduce discharges by more than those with higher costs. Two important objections to such a tax that contribute to its unpopularity – the possibility of a heavy tax burden on farmers, and the rather loose relationship between fertiliser application and nutrient discharges already referred to – can be largely overcome (see Box 1).

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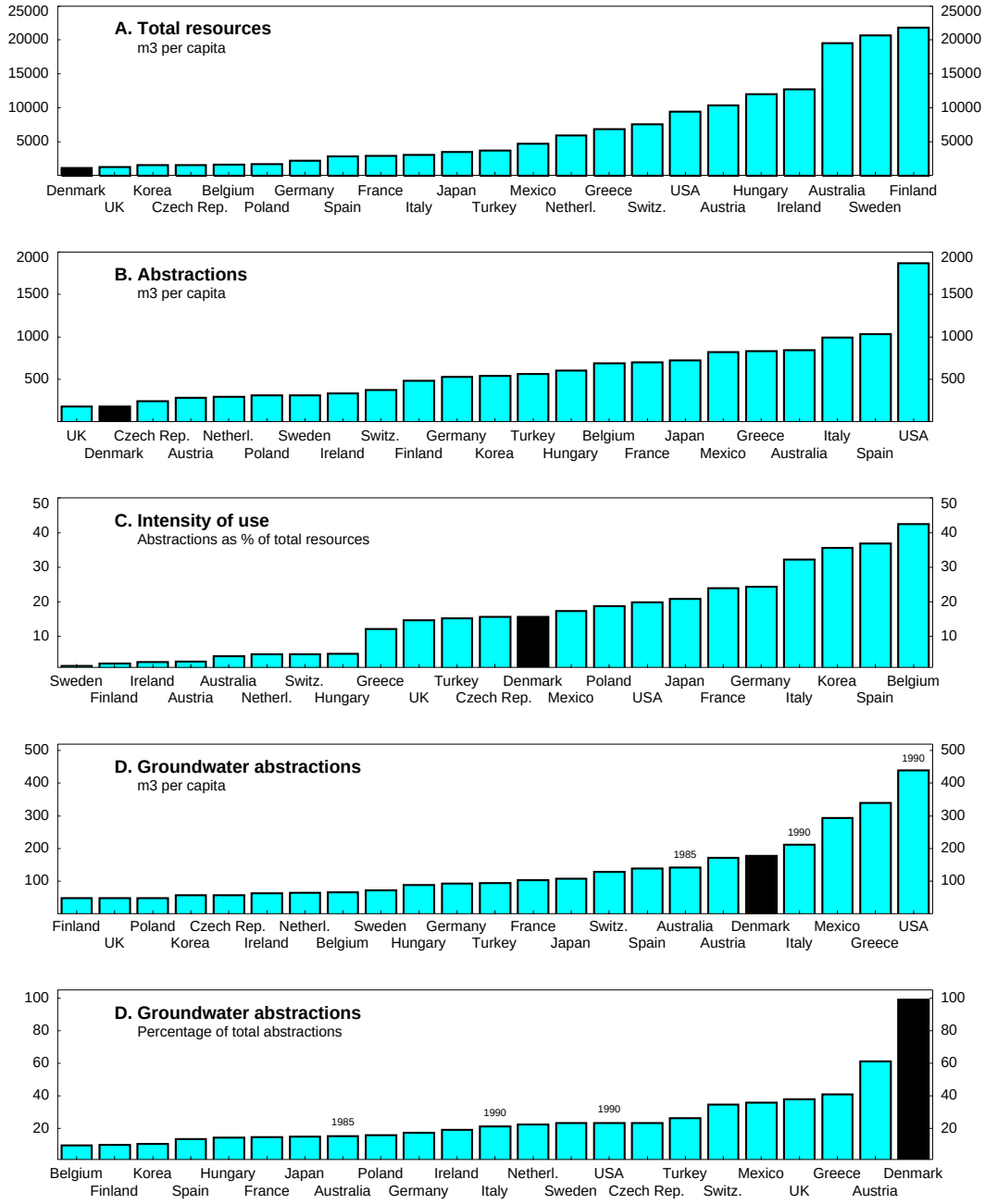
10. Wastewater from fish farms is not subject to the waste water tax. Businesses registered for VAT can obtain a reimbursement of 97 per cent of the tax exceeding DKr 20 000 a year if 80 per cent of the production is connected to the processing of fish or the production of cellulose or of sugar. A reimbursement of 70 per cent of the tax exceeding DKr 20 000 a year is possible if 80 per cent of the production is connected to production of organic pigments, of pectic substances, gelatine, etc. or of vitamins. Thus, some of the largest polluters are subject to an intricate set of exemptions, a pattern that occurs in energy taxation as well.

11 A similar approach is used for phosphates in the Netherlands.

Figure 2. Water resources in Denmark: an international comparison
1997



Source: OECD Environmental Data Compendium, 1999.

Box 1. **Taxing fertiliser?**

There are two objections to a nitrogenous fertiliser tax: that it would be a heavy burden on farm finances, and, secondly, that it may be an ineffective means of reducing nitrogen leaching from farmland. The first is simple to deal with, the second more difficult.

Certainly, a tax paid on all fertiliser use would imply a large tax bill. But all farms could be given a tax credit equivalent to the tax payable on, say, their current fertiliser use target. If they use exactly their target amount they will face no net tax bill, as at present; if they use less they would be able to keep some of the tax credit. By creating more consistent incentives to reduce fertiliser use this would be a more efficient and effective method than the present one, even if the tax were set at a lower rate than the current fines. An alternative way of implementing a system with similar incentives would be to issue fertiliser-use permits and make them tradable. Whether a tax or tradable permit system were used, it could be progressively tightened if necessary, by increasing the rate of tax or reducing the total permit issue. Some revenue could be raised, under either system, by setting the tax credit equivalent to somewhat less than likely average fertiliser use or, in the case of a tradable permit scheme, by charging for all or part of the initial permit allocations.

The problem with the fertiliser tax as an efficient instrument is that while the tax can be calibrated on the amount of nitrogen applied to land, the target is the amount of nitrogen that leaches from the land into surface and ground water. But the nitrogen cycle on a farm is complicated, depending on the crops grown, use of animal manure and so on. Under some circumstances, an increase in the cost of fertiliser may cause shifts towards the production of crops that need less nitrogen in the soil, but which may also retain less nitrogen, so that even as nitrogen application is reduced, leaching could *increase*. The only reliable way round this problem is to measure flows of nitrogen on and off farms (nitrogen can leave embodied in crops, animals or animal manure), levying a tax on the difference between the two, which is what must be left in the soil and liable to end up in surface water; see Hansen (1999) for a detailed description of a possible scheme. This might imply a heavy administrative and data-gathering burden and the costs of this might not be worth the gain in efficiency compared with a simple tax on the nitrogen content of fertiliser. However, in the Danish case, all the necessary information is already collected in the farm-by-farm nitrogen fertilisation accounts that cover all farms. The incremental cost of maintaining the reliability of the data (the incentive to misreport might be increased under a general tax) would probably not be very high. A tradable permit scheme could be applied here.

Any of these systems could be adapted to recognise that nitrate discharges are more damaging in some areas than in others, by making the tax payable, or number of permits required, per kilogram of nitrogen, a function of the estimated marginal damage done in that locality.

19. Of course, beyond a certain point, further reductions in nutrient inputs to farmland imply degradation of fertility – it might seem bizarre to give tax incentives for this. However, if the environmental problem is sufficiently serious, this is the logical approach, just as governments are willing to accept the social costs of relocating or closing a sufficiently heavily polluting factory.

20. As in all European Union countries, and most OECD countries, it is ironic that agriculture is at the same time one of the most highly subsidised industries and one of the most highly polluting industries. Furthermore, the main subsidy, through high guaranteed prices, act on marginal production and thus are an incentive to more fertiliser use. While set-aside programmes reduce the amount of cultivated land and therefore the amount of land to which fertiliser is applied, they retain the incentive to intensive cultivation of the remaining land. From this perspective, a fertiliser tax on agriculture can be seen as part of moves towards a more sustainable agricultural policy.

21. Agriculture has had an enormous effect on the Danish landscape as well. Some programmes are underway to reverse some of the consequences of this influence. Watercourses that had previously been straightened to improve drainage are being restored to their “natural” beds, forest cover is being targeted to

double over the next 80 to 100 years; some animals (beaver, native salmon) are being reintroduced into the wild too. These programmes are financed out of general taxation.

3.1.2 Water charges and taxation

22. The pricing structure for water supplies follows recommended "economic instrument" approaches, with full cost recovery and charges based on consumption (see OECD, 1999*d*). Up to the mid-1980s, water prices were among the lowest in the OECD. Subsequently, the heavy investment required to try to meet the targets of the aquatic action plans increased charges considerably and by 1995 the tax-inclusive price of water to households in Denmark was the highest among OECD countries for which data were available (OECD, 1999*d*). Since the water tax has risen substantially further, this is probably even more the case now. (As far as households are concerned, wastewater treatment and the wastewater tax described above is paid by local water companies and passed on in water charges.)

23. A rise in prices would be expected to finance interest and amortisation on the investment necessary to implement the targets of the aquatic action plans. It seems that the intention was in fact to avoid borrowing completely and to finance all the investment out of cash flow from increased charges, but some borrowing was nevertheless necessary despite the large price increases. With the addition of the water tax and waste-water tax, total revenue from water charges and taxes probably more than finances the ongoing costs of supply and treatment facilities, although it may also be the case that the relatively small scale of most water supply facilities keeps costs relatively high.

24. Industry is exempt from the water tax, which is paid only by households. Although the water tax is only one of four volume-related payments,[12] industry is in a sense cross-subsidised at the margin by households. The authorities argue that the industry exemption compensates for water suppliers' inappropriate charging structure – there is no fixed element and all costs are covered through a uniform volumetric tariff, which thus exceeds the marginal cost of supplying water. This might still involve some cross-subsidisation and leaves no-one paying the appropriate marginal cost (unless the external costs of water use are higher than the taxes); a restructuring of water charges would be appropriate. Consumption of water has fallen since the charges and taxes were increased, though the implied price elasticity of demand is low, a useful property from the point of view of raising revenue.

25. With water in Denmark apparently relatively scarce, surprising as this may seem, charging a resource rent – revenue from water charges and taxation exceeding the actual costs of supplying it – makes sense. While also being a convenient source of general government revenue, this has had the effect of reducing consumption, which fell some 20 per cent between 1980 and 1997. Water supply and treatment is mostly provided by municipalities, though one-third is provided by private water works. Municipalities are free to join with their neighbours to operate larger scale plants to benefit from economies of scale. The regional variation of charges appears mostly to reflect variations in local conditions, but the magnitude of such variation (the Confederation of Danish Industry reports that charges per cubic metre vary from DKr 5 to DKr 45) suggests that there may be efficiency gains available in some places and that local administrations do not have sufficient incentive to search for them – given their statutory right to charge whatever is necessary to cover costs and highly price-inelastic demand. The slow progress in reducing groundwater nutrient contamination increases the importance of incentives to search for cost-efficient treatment methods, as well as reinforcing the need for what is emerging as a significant cost-externality from agriculture to be addressed in that industry.

12. The four are water and waste water charges, paid to the local water company, and the water and waste water taxes, which accrue to central government.

3.2 Waste disposal

26. Denmark makes considerable use of economic instruments in managing non-hazardous waste. A general tax on waste disposal was introduced in 1987 at a low level, rising during the 1990s and from 1993 onwards being increasingly differentiated according to the method of disposal (Table 1). With specific duties on a number of individual products (for example, plastic bags, tyres, disposable tableware, rechargeable NiCd batteries, electric bulbs) or materials, in addition to the general waste disposal tax, Denmark probably has higher taxation on waste than any other OECD Member country.[13]

Table 1. **The Danish waste tax**

	DKr per tonne ($1= DKr 7 approx.)				
	1987	1990	1993	1997	1999
Delivered to incineration with electricity cogeneration	40	130	160	210	280
Delivered for other incineration	40	130	160	260	330
Delivered to landfill	40	130	195	335	375

1. Waste disposal *charges* also vary according to the method of disposal, averaging DKK 245, 325 and 285, for incineration with cogeneration, other incineration and landfill, respectively, in 1999.

Source: Ministry of Finance (1999).

27. Many of these taxes were first imposed, or increased, in the early 1990s as part of the shift towards "green" taxation which financed a necessary reduction in marginal taxes on income and labour. They are not typically calibrated from an explicit calculation of environmental damage, and the need to raise revenue may sometimes have taken precedence over structuring taxes so as to provide the desired incentive effects. Such a structure is not easy to achieve, especially for municipal waste. Collection and disposal of municipal waste are the responsibility of municipalities, which therefore pay the waste tax in the first instance. Local government is required to charge so as to cover costs including taxes. Thus, while a few municipalities charge individual households by the weight of their waste, the vast majority simply set flat rate charges to cover tax-inclusive costs. In the latter case there is no incentive for households to reduce their production of waste; there is some evidence[14] that waste production falls markedly if weight-based fees are imposed at the household level. The feasibility of such a system will vary according to the municipality – where there are many multi-occupied dwellings it would be much more difficult to pass on the by-weight charge to individual households. Only fourteen municipalities currently use such charging systems, and there are concerns that they lead to increases in illegal dumping.

28. In practice, waste policy is strongly influenced by central targets, whose emphasis is on recycling. For each of a number of different types and sources of waste, a certain percentage of recycling,

13. The current tax on retail containers distinguishes 22 kinds, with rates differentiated by material and size. Its complexity probably imposes substantial administrative costs. No analysis on whether environmental benefits justify these costs appears to have been undertaken, although the measures have been subject to a number of revisions, partly to try to reduce the administrative burden.

14. See Andersen (1998), quoting Statens Byggeforsknings Institut (1996). Andersen (1998) reports that in two communities that adopted weight-based fees in the mid-1980s residual *(i.e.* non-recycled) waste fell to about 100 kilo per capita, compared with 200-300 kg per capita in communities with recycling facilities but without a weight-based charge.

incineration and landfill disposal is targeted. The overall target for the year 2000 was for a high level of recycling (54 per cent) and for maxima of 25 per cent and 21 per cent for incineration and landfill respectively. The recycling target share was already exceeded in 1996 (OECD 1999*c*), and there is now a target of 60 per cent recycling for 2004. Although the tax system described above provides some incentive for incineration, particularly if burnt in electricity generating plants, it was strongly reinforced by a 1997 administrative directive that requires that anything that can be incinerated, must be.

29. One interesting area in the recycling debate is glass bottles used in the beer and soft drinks industry. The use of metal cans is banned, and a mandatory deposit/refund scheme is in operation to encourage bottles to be returned to the point of sale. Domestic brewers can re-use multiple-use bottles once collected and thus avoid the DKr 0.5 tax on new bottles, but foreign brewers would face high transport costs in doing this and therefore in practice have to recycle (rather than re-use) the glass. Some claim that the combined effect of the ban on cans and the deposit-refund system is protectionist; the European Court is to rule on this later this year in an action brought by the European Commission. Certainly, if non-re-used bottles and cans paid only a tax similar to the landfill tax, the cost of supplying the Danish market from abroad would be much lower; however, this cost may not take into consideration other factors that may contribute to the marginal social cost of non-re-used bottles.[15]

30. The priority given to re-use and recycling reflects the "waste-hierarchy" approach increasingly used by many European countries. This approach can work well provided a comparison of benefits and costs – both economic and environmental – is allowed to influence the choice of waste-disposal method. The introduction of differentiated waste taxes has moved Danish policy further than most countries in this direction, but the retention of quantitative targets and out-right bans (such as that on landfill disposal of any waste that can be incinerated) reflects a reluctance to rely completely on economic instruments. To a considerable extent this may be explained by the difficulty of agreeing explicit social valuations of environmental benefits and costs. While the command and control approach involves implicit and quite possibly inconsistent valuations, this approach may well nevertheless be more socially acceptable, especially since it can serve to implement European directives, such as the goals of the Landfill Directive.

3.3 Energy

31. The energy sector is at the heart of many aspects of Danish environmental policy, concerning both policy targets and instruments to achieve them. These include: international agreements on cross-border pollution;[16] an emphasis on renewable energy (that predates concern with global warming); ambitious targets for reducing greenhouse gas emissions; a mixture of central planning and economic instruments; and a structure of taxation influenced by sectoral and fiscal considerations as well as by environmental interests. The picture is complicated by the fact that the electricity sector is in the midst of being reformed, with the intention being to move towards a more competitive market system, though this process has only just begun, and it is not yet clear what the final outcome will be. This section begins by focusing on the complicated structure of energy taxation, which reflects many of the main environmental issues.

15. The deposit, equivalent to several thousand krone per tonne, is very high compared with the waste disposal tax – see Table 1 – but the appropriate comparison may be with the marginal social cost of bottles left in the street rather than of those arriving at a landfill site.

16. Specifically, the relevant accords are the EN-ECE Convention on Long Range Trans-boundary Air Pollution (for acid rain), under which a new "multi-effects" protocol was signed in December 1999, and the United Nations Framework Convention on Climate Change.

32. Denmark already had an energy tax in the late 1970s, which was generally levied on the energy content of different fuels; the rate was increased in 1986 and natural gas exempted. During the 1990s the tax structure has evolved, and there are now three different taxes: the energy tax, the CO_2 tax and the SO_2 tax. Table 2 shows the main elements. The number of different tax rates and the range of variation are striking.

Table 2**. Tax rates on energy, 2000**

		Energy tax DKr per 10^9J	CO_2 tax DKr per tonne	SO_2 tax DKr per Kilogramme
Fuel used for electricity production		0	0	10
Electricity		48[1]	100[2]	
Fuel used for all residential and Commercial purposes, and industrial space heating	Coal	47	100	10
	Oil	48	100	10
	Gas[3]	48	100	10
Light industry	Without VA[4]	0	90	10
	With VA[4]	0	68	10
Heavy industry	Without VA[4]	0	25	10
	With VA[4]	0	3	10

1. The energy tax is levied on electricity supply at a rate equivalent to DKr 48 per GJ of coal energy, assuming that all such electricity is generated from coal at average efficiency rates for Danish power stations. In addition, two special duties are applied.
2. The "CO_2" tax on electricity is levied — except on that from renewable sources — at DKr 0.1 per KWh. This rate is equivalent to DKr 100 per tonne of CO_2 from coal, assuming that all such electricity is generated from coal at average efficiency rates for Danish power stations.
3. Gas is priced as a function of the tax-inclusive price of competing fuels. Gas suppliers pay DKr 40 per GJ tax, retaining DKr 8 "shadow tax".
4. VA: voluntary agreement.

Source : OECD, Danish Ministry of Taxation.

33. Introduced in 1996, the SO_2 emissions tax rate, at DKr 10 per kilogram, corresponds to approximately $1 200 per tonne, compared with a current market price for emission permits of around $200 per tonne in the US SO_2 trading scheme (and the $2 000 per tonne penalty for entities that exceed their permitted emissions in that scheme). The Swedish tax is somewhat higher; the environmental costs of such emissions vary a lot according to location, however. According to the Ministry of Taxation, the rate was chosen to correspond to current estimates of the marginal environmental cost of SO_2 emissions, although it is somewhat lower than the figure used in the green saving adjustment mentioned earlier, and much lower than that used in the Energy and Environment Ministry to assess the costs and benefits of the wind turbine programme (see below).[17]

17. Prior to 2000 electricity generation did not pay the SO_2 tax directly, since Denmark was limiting its emissions under an internationally-agreed quota scheme that adjusted for electricity trade. A supplementary tax on electricity consumption, calculated according to the implicit sulphur content of electricity used domestically, nevertheless allowed the revenue to be collected – largely for fiscal purposes. This device circumvented EU restrictions on differential taxation of traded electricity. From 2000 onwards the quotas under the agreement (following the Göteberg Protocol) no longer adjust for trade in electricity.

34. The "energy tax" is payable only on household and non-commercial uses and industrial space heating. Exempting fuel used in electric power generation allows both domestically-generated and imported electricity used in Denmark to be taxed at the same rate, although there is no environmental reason why this should be necessary. The energy tax does not appear to have a specific environmental justification, in fact, although it is often – and sometimes misleadingly – recalculated as an implicit tax on CO_2.[18] There are a number of environmental externalities that arise from use of energy, so taxing it has environmental benefits. But since the externalities do not generally depend on energy content itself, it is not a precisely targeted tax, especially since industrial energy use is untaxed.

35. The carbon tax also appears irrational at first sight. If the purpose of the tax is to internalise an externality due to CO_2 emissions, then the structure only makes sense if this externality is at least four[19] times higher in the case of emissions for space-heating purposes than for certain energy-intensive industrial processes, whereas in fact the external costs of CO_2 emissions are the same whatever the source. The exemption of SO_2 emissions from electricity generation also made little sense, though this exemption was removed at the beginning of 2000.

36. Two parallel, and difficult to distinguish, arguments are used to justify this deviation from a textbook uniform tax. One argument is that such a tax would damage the competitiveness of energy-intensive activities, leading to a loss of jobs and output; taken on its own, this argument is not very convincing, since the overall costs of reaching a given domestic emissions target are increased if heavy emitters are given special treatment (see Box 2). The second argument takes the first a step further: not only (it is argued) would output and employment in Denmark fall as, for example, cement production were curtailed, but the lost production capacity would move elsewhere, to countries where taxation is lower or absent, leaving global CO_2 emissions broadly as before. In these circumstances, given the Danish authorities' approach of targeting global emissions (see below), the optimal tax structure would not be uniform but would vary with the ease with which emissions intensity can be reduced. Once major foreign competitors pay the same rate as Danish producers, there will be no need for reduced rates for certain sectors. Under the Kyoto Protocol, such "leakage" is unlikely to be a major problem, since most of Denmark's trading partners will also be trying to reduce their emissions, and such leakage as occurs will be to developing countries.

37. Denmark is committed to the targets of the Kyoto Protocol, but is also maintaining its commitment to the target of the 1988 Toronto Agreement, to limit CO_2 emissions in 2005 to 80 per cent of their 1988 level. Although the wording of the Toronto Agreement does not specify that such reductions should be achieved without leakage, the Danish authorities interpret the target in this way, because they hope that the resulting demonstration effect will increase the chances of a global agreement being reached.[20] Once it is clear that the Kyoto Protocol will come into force, the authorities have stated that they will remove the differential provisions of the energy and CO_2 taxes designed to protect vulnerable industries and minimise leakage.

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18. When so calculated, it is some DKr 600 to 700 per tonne of CO_2 – much higher than the CO_2 tax itself. The precise figures depends on the fuel, since the energy tax is calculated on the energy content, not the CO_2 content, which varies according to the fuel.

19. Comparing the highest and lowest nominal tax rates would give an implicit ratio (DKr 100 versus DKr 3 per tonne) much higher than four. The lowest tax rate, at DKr 3 per tonne, is applicable only to firms who have accepted the terms of energy-saving voluntary agreements, which, the Energy and Environment Ministry argues, has an effect equivalent to that of imposing the CO_2 tax at DKr 25 per tonne.

20. The Toronto Agreement was largely superseded by the 1992 UN Framework Convention on Climate Change and the Kyoto Protocol to that Convention. Very few countries are likely to meet the Toronto targets, though Denmark will get nearer than most. According to government analysis, current measures are sufficient to reduce emissions in 2005 to 15 per cent below the 1988 level (Finance Ministry, 1999).

38. To counter the fear that setting low tax rates for heavy energy users gives no incentive to reduce emissions, the lowest rates are conditional on an enterprise reaching a voluntary agreement[21] (VA) on action to reduce energy consumption in the enterprise. This is an interesting experiment, which can be thought of as a way of implementing some properties of the tax-credit approach mentioned in Box 2, but which prevents firms closing down and keeping the tax credit. To be taxed at DKr 3 per tonne of CO_2 a firm has to undergo an energy audit, and undertake any energy efficiency improvements which would be profitable (defined as having a pay-back period of four years or less) if the DKr 25 tax rate were applied (to be fully equivalent to the tax credit system would require carrying out all investments profitable at the full DKr 100 per tonne rate). If the energy audits were reliable and continuously updated, and in the absence of transaction costs, this would be equivalent to applying the tax at DKr 25 with a tax credit roughly equal to DKr 22 per tonne of baseline emissions. Krarup (1999) casts some doubt on the efficacy of entering into making voluntary agreements, concluding that the undoubted energy efficiency improvements that have been seen would in many cases have occurred even without the voluntary agreements. However, the authorities have extended the scheme (albeit with some amendments) based on the results of an independent evaluation carried out for the government, which indicated that the scheme is effective. Although the scheme is ingenious, it probably entails additional administrative costs, as well as, at best, preserving the distortion inherent in the difference between the DKr 100 tax rate applied to households and the DKr 25 rate for industry.

39. Taxing carbon emissions will eventually lead to a switch towards less carbon intensive fuels. The Danish authorities have accelerated this trend over the last decade by strongly supporting renewable energy in general and wind turbines in particular.

3.3.1 Wind turbines

40. There has been a rapid expansion of wind-generated electricity in Denmark, now providing about 9 per cent of total supply, with some 5 300 wind turbines. Technology has made rapid progress over the past decade, and, as the rated capacity of new wind turbines has risen from 55 kW in the mid-1980s to the present 750 kW, average production costs for newly installed wind turbines (in a prime location) have fallen by around half, to around DKr 0.30 per kWh.[22] The move towards larger wind turbines is expected to continue with the projected sea-based wind turbines of 2 000 kW or more,[23] development of which is intended to provide the bulk of the planned doubling of renewable energy production. Danish wind turbine producers have profited from the rapid growth of their domestic market, and are thought to supply around 60 per cent of the world export market.[24]

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21. This may be a misleading use of the term "voluntary", since there are significant penalties for not complying.

22. Renewable sources of energy, with special emphasis on wind energy. Committee on New and Renewable Sources of Energy and on Energy for Development. Report of the Secretary General. Prepared by R. Redlinger, P. Dannemand Andersen and P.E. Morthorst, Risø National Laboratory. The marginal cost of coal-generated electricity is around DKr 0.20 per kWh.

23. A. Larsen and J. Munksgård (1996) Samfundsmæssig værdi af vindkraft, AKF Hovedrapport, København.

24. The six largest Danish wind turbine producers, who each export more than 80 per cent of their production, are among the ten largest producers in the world.

Box 2. **Competitiveness**

Recent OECD Economic Surveys have discussed the influence of worries about competitiveness (in particular, those of Finland and Germany). In Denmark, too, systems of environmental taxation or regulation are distorted by a desire to reduce the extra tax burden facing certain industries compared with their competitors abroad, presumed to have less onerous regulatory or tax burdens. They are subject to less stringent regulation, exempted from taxation or allowed reduced tax rates, compared with other activities.

It is of course true that some industries will be particularly hard hit, forced to contract and perhaps to close down altogether, if they face the full burden of taxation or regulation while facing competition from overseas such that demand for their output is particularly price-elastic. But these will necessarily be the most polluting industries. From an environmental point of view they *should* contract if competitors in other locations can produce with less pollution, or if a lower price is attached to the relevant environmental damage in those locations.[1] The loss of employment has to be dealt with in the same manner as with any structural change in the economy. Similarly with regional problems – many of the *realpolitik* issues are actually to do with regional concentrations of particular activities.

Exemptions or reduced rates for heavy polluters are costly:

- Other domestic industries or activities are disadvantaged with respect to the protected industry;
- Overall costs of dealing with the environmental problem are increased.

To reach a given level of pollution abatement from Danish territory, exempting an activity means that the tax rate, or degree of regulation, on others has to be higher. Those activities then have to contract more than they otherwise would. Furthermore, since those activities will generally be less pollution-intensive than the exempted industries, the overall loss of output and possibly employment is likely to be higher than otherwise.

Exemptions are not the only way to soften the impact: compensation schemes (perhaps in the form of tax credits) or tradable permit schemes can reduce the competitive disadvantage without diminishing the environmental incentives.

A tax has an income effect and a substitution effect. In the long run it is the substitution effect that will change behaviour, but in the short run the income effect may threaten the survival of a firm. Compensation schemes using tax credits (as in Sweden for NO_x) or "grandfathered" tradable permits (as in the United States for SO_2 and NO_x) mean that the full tax rate can apply to all activities. The substitution effect is the same for all, allowing – in principle – cost-minimising adjustments overall. But some activities are sheltered from the income effects. Of course, since sheltered industries may delay their adjustment, income and substitution effects are not so easily separable in practice.

In Denmark, a particularly important example arises in the CO_2 /energy tax. There is no "correct" level of tax on different forms of energy – a number of different environmental problems are linked to them and the resulting costs are not easily valued. But the inefficiencies of using such a wide range of tax rates for CO_2 are clear; even if the cost (and therefore the "correct" rate) is not known, there is a definite overall quantitative target, and efficiency requires that all emitters face the same marginal cost.

Heavy energy-using industries, such as steel and cement, successfully argued that they should not be subject to the full tax, since they compete with companies overseas not facing the same constraints. Regional concerns probably bolstered their case (they tend to be dominant employers in the regions where they are located). In order to be entitled to have lower rates of tax applied, firms must reach "voluntary" agreements (VAs), which amount to an obligation to undertake energy-saving investment (identified as profitable in an energy audit). In its effect on abatement incentives, the VA system has some similarities to the tax credit approach: trying to give firms an incentive to reduce emissions without burdening them with heavy tax payments on the bulk of their emissions. But the marginal costs of abatement will differ across firms, and a new set of incentives will need to be introduced in the future, since emissions will certainly grow too fast, or diminish too slowly, in the absence of the continuing incentive that a higher marginal tax rate would provide.

Thus, although it is true that international co-ordination of tax rates, regulations or permit schemes would allow more efficient solutions to emerge, reducing the marginal abatement incentives for the major offenders on competitiveness grounds is not efficient and is rarely the only means available to reduce adjustment costs.

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1. The main text notes that Danish policy attaches importance to pollution in other countries as well as that in Denmark. Such an altruistic approach leads to a different interpretation of the competitiveness issue; but it can also be used by sectoral interests to argue for special treatment.

41. The high cost of producing wind turbine electricity has required substantial public subsidies to enable the sector to expand, totalling almost DKr 4 billion over the past six years and reaching almost 0.1 per cent of GDP in 1998 (Table 3). These subsidies come in three main categories: production subsidies, tax subsidies for co-operatively owned wind turbines, and guaranteed prices for wind-generated electricity.[25]

- The current production subsidy was introduced in May 1992 (replacing a tax exemption introduced in 1980). The subsidy has two components: DKr 0.10 per kWh for both independent wind turbines and those owned by the main generators; DKr 0.17 per kWh paid only to independent wind turbines;
- Co-operatively owned wind turbines are exempted from tax, leading to tax expenditures in the order of DKr 70 to 90 million per year;
- The guaranteed price was determined as 85 per cent of the consumer price for electricity excluding taxes and subsidies. The effect is that electricity distributors (the purchasers of wind-generated electricity) pay 0.12 to 0.13 DKr per kWh more for wind turbine electricity than the estimated marginal feed-cost to the grid of 0.20 DKr per kWh.

Table 3. **Wind turbine subsidies, 1992-1998**

DKr million

	1993	1994	1995	1996	1997	1998
Wind 10-ore	100	118	136	122	193	216
Wind 17-ore	134	153	165	155	262	390
Tax expenditures	67	67	69	76	83	88
Price subsidy	143	158	165	157	256	359
Total	444	496	535	510	794	1053
Unit subsidy, øre per KWh	42.9	43.6	45.6	41.6	41.1	37.9

Source: Ministry of Finance; Statistics Denmark; Ministry of Environment and Energy; Danish Wind Turbine Association; OECD calculations.

42. The size of the total subsidy relative to production costs has increased over time. Although the amount per kWh has declined by 11.5 per cent in real terms since 1990, wind turbine efficiency has increased four times faster. An average wind turbine installed in 1998 has production costs of around 0.32 DKr/kWh and sells at 0.60 DKr/kWh, a margin of nearly 100 per cent compared with a 5 per cent margin ten years earlier. As a result, the post-tax rate of return on investment in wind turbines (with low risk since output prices are guaranteed by the government) had risen to between 10 and 17 per cent[26] by 1999, compared with post-tax rates of return of around 4 per cent on government bonds.

25. Other indirect costs are associated with necessary investments in the electricity grid to accommodate new windmills, although since such investments are difficult to separate from other investment costs, and they are not included in the presented calculations.

26. According to the Economic Council.

43. In the future, the effective rate of subsidy is likely to decline as the system of "green certificates" is now under implementation and the subsidies described above will be phased out; it should provide a more cost-effective way of meeting what is itself a rather arbitrary target – satisfying 20 per cent of electricity demand from renewable sources by 2003. Green certificates will represent units of electricity generated from renewable sources; electricity consumers will be obliged to acquire certificates corresponding to a yearly quota of their total electricity consumption (20 per cent in 2003); renewable electricity generators will supply certificates according to how much they generate and supply. Hence the payment for wind electricity will consist of the market price plus the price of green certificates. Using certificates, rather than insisting that each distributor actually purchases 20 per cent of its electricity from renewable resources, provides useful flexibility, for example in avoiding unnecessary transmission costs.

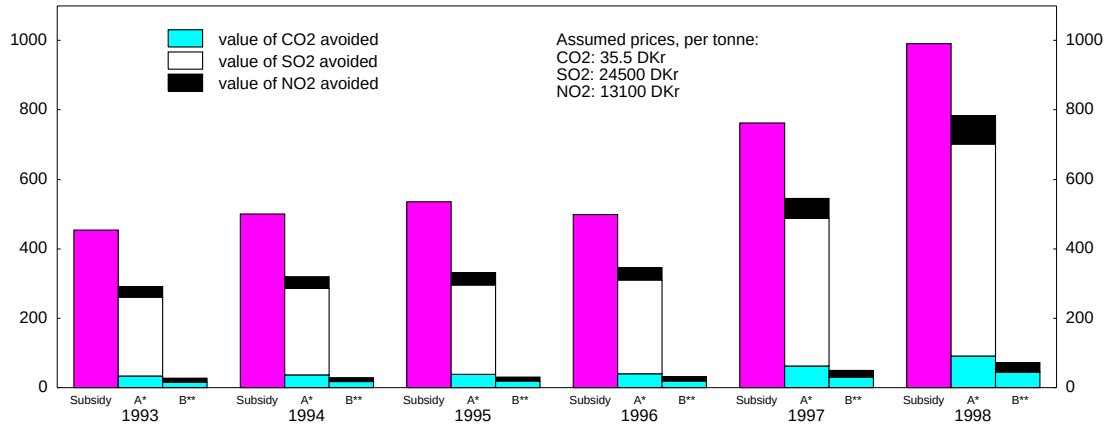
44. The level of subsidy is uncertain in such a system. The government has set upper and lower limits on the price, of 0.27 DKr and 0.10 DKr per kWh respectively. The upper limit caps the subsidy (at the current level) even if not enough "green" electricity is generated – distributors will pay a "fine" of 0.27 DKr per kWh of the difference between the quota and the number of green-certificates they have purchased on the market; the lower limit guarantees a subsidy to wind turbine operators even if capacity installed exceeds the quota.

45. The aims of the wind turbine programme appear to be threefold: reducing greenhouse gas and other emissions, improving security of energy supplies and supporting technological development. The government has not published any kind of cost-benefit analysis of the programme, perhaps because valuation of some of the benefits is difficult. It is possible, however, to put approximate valuations on the emission reductions and compare the resulting figures for benefits with the expenditure on subsidies. The quantity of emissions saved depends on how the electricity would have been generated in the absence of wind turbines. In Denmark's case it is coal generating plants that have been run down, so coal emissions might be the obvious comparator, but they could have been replaced by gas generation rather than wind turbines. Figure 3 illustrates an approximate comparison, though the figures are based on a number of assumptions about technology and valuation (see Box 3) and does not consider, for example, the subsidies to the gas distribution network.

46. This is far from a full cost-benefit analysis, but some implications are clear, particularly since it makes more sense to assume that wind turbines displace gas-generated electricity than that they replace the "dirtier" coal. This is because although the output of coal-fired stations has been reduced, they are generally far from the end of their economic life. Only the variable costs of running them would enter cost calculations, whereas the full capital cost of wind turbines and gas stations (gas's contribution to electricity generation is also expanding) is relevant. At the illustrative prices used, and if capital costs are not too dissimilar, the environmental benefits of using wind turbines instead of gas are far less than the subsidy to wind turbines.[27] If the choice were only between coal and wind turbines, the gap is narrower, but it would be better to replace coal with gas rather than wind unless either the omitted net benefits were substantial, or CO_2 emissions were valued at over DKr 250 per tonne; such a valuation is likely in the near term only if the Kyoto Protocol is implemented and enforced with quite severe restrictions on international trading of emissions permits, and if the ability of Denmark to cut back on non-CO_2 GHGs such as methane and NO_2 were small (whereas in agriculture there are probably significant low cost abatement options).

27. Using the full amount of the subsidy as a cost may be an overstatement, since in recent years much of it has become a transfer payment rather than a resource cost. On the other hand, the distortions involved in raising revenue are usually taken to imply that the full economic cost of subsidies substantially exceeds the simple budgeted amount. No adjustment for either of these factors was made in the illustrative calculations presented here. Possible environmental costs such as visual impact are also ignored, though they may be important.

Figure 3. Costs and benefits of the wind turbines programme
DKr million



* A: value of emissions avoided if wind turbines replace coal.
** B: value of emissions avoided if wind turbines replace gas.

Note: The prices used here are illustrative, not intended as an explicit estimate of the environmental costs of emissions. They correspond to those used for the "green adjustment" shown in Figure 1.
For each year the second and third columns represent the value (see footnote 5) of the emissions that would have occurred if, respectively, coal or gas fired power stations had been used to generate the electricity that was produced in that year by wind turbines.

47. However, environmental objectives are not the only goals of the wind turbine programme. One cited by the authorities is technology stimulation.[28] The technology argument is bolstered by the fact that Danish wind turbine producers are among the world's most important. Valuing this is difficult, however. Although exports of wind turbines are substantial (reaching about DKr 11 billion in 1999), this means little unless the value added in their production exceeds the value that would have been produced in alternative uses of the resources. This means that Danish wind turbine producers have to be earning a rent, due either to their technology or to their market power. This may be true, but the market for wind turbine supply seems to be fairly competitive, as well as being quite heavily dependent on subsidies in other countries. For example, California was an important market until the degree of subsidisation there was cut substantially.[29]

28. Energy security is also cited. Since coal is entirely imported, wind turbines may be a more "secure" source of supply in time of war (the earliest power-generating wind turbines were built during the second world war); for the moment, Denmark is self-sufficient in natural gas so this would be a secure source too.

29. A further argument would be that, if these successes were to be taken as a justification for the wind turbine programme, it would be an example of a government successfully "picking winners"; in a cost-benefit analysis the costs of "losers" that have been picked would have to be set against these benefits.

Box 3. **Valuing the benefits of wind turbines**

Figure 3 – which is for illustrative purposes and is not intended as a definitive statement on the net benefits of the wind turbine programme – compares estimates of the costs of the wind turbines programme with estimates of some of the benefits, specifically the reduction in emissions of carbon dioxide and oxides of sulphur and nitrogen. To do this, it is necessary to estimate both the quantity of emissions avoided and the environmental cost per unit of emission. The quantity avoided depends mainly on the kind of fuel assumed to be supplanted by wind, but also on some technology assumptions – combustion techniques, use of "scrubbers" for SO_x and NO_x , for example. Valuation depends on assumptions about environmental damage avoided and its social worth. In the present exercise both sets of assumptions are relatively crude but make use of easily available information.

Emissions avoided [1]

It is assumed that the coal (gas) stations replaced by wind turbines would have emitted CO_2 at the average rate, per kWh of electricity generated, of all Danish coal- (gas-) fired stations in 1997. In the absence of data on SO_x and NO_x emissions from Danish stations, it is further assumed that tonnes of SO_2 and NO_2 emissions in those stations would have borne the same proportion to CO_2 emissions as was the case in typical US stations in 1998. The CO_2 assumption is likely to be accurate; those for SO_2 and NO_2 could be out by a factor of 2, especially for coal stations, depending on whether emission control technology would have been in place or not, for example.

Valuation

Emissions were valued as in the "green adjustment" to national saving referred to earlier: CO_2, SO_2, and NO_2 valued at DKr 35.5, 24 500 and 13 100 per tonne, respectively. The valuation attached to SO_2 may be rather high (alternatively, the current tax on SO_2 emissions, which is only 40 per cent of the value used here, is rather low). The prices used in this analysis were used by the Danish Economic Council in 1997. Only one year earlier, in 1996, the Economic Council used much higher prices. Using these higher prices, the wind turbine subsidy per kWh would substantially exceed the environmental costs of coal-generated electricity but not that from gas. This indicates that the uncertainty in the valuation of environmental benefits is quite high, reinforcing the need both for caution in the use of cost-benefit analysis where valuation is uncertain and for consistency in the use of whatever information is available. The Ministry of Finance and the Ministry of Environment and Energy are at present working on a more thorough investigation of existing studies on the valuation of benefits in the environmental field.

The assumed valuation of CO_2 is at the low end of the likely range for trading under the Kyoto Protocol; unless trading under the Protocol involves a number of significant developing countries, not currently signatories, the CO_2 price in such trading is likely to be two or three times higher than that used here. See OECD (1999*e*).

With these assumptions, reduced CO_2 emissions account for about 12 per cent of the benefits in replacing coal-generated electricity, SO_2 and NO_2 emissions accounting for 78 per cent and 10 per cent respectively. For gas stations, the corresponding percentages are 62 per cent, 0 and 38 per cent.

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1. CO_2 emissions data for Denmark are from the International Energy Agency. Data on emissions from US stations is taken from the "Emissions Scorecard" of the Acid Rain website of the U.S. Environmental Protection Agency, http://www.epa.gov/acidrain/score98/es1998.htm. Data used are from the Emissions Scorecard, "Appendix B: 1998 Data for SO_2 , NO_x, CO_2 , Heat Input, and Other Parameters" – *http://www.epa.gov/acidrain/score98/table_b2.zi*p, as on 25 January 2000. Thus, per GWh of electricity generated, it is assumed that coal-fired stations would have emitted 920 tonnes of CO_2 , 8.96 tonnes of SO_2 and 2.24 tonnes of NO_2; for gas, the corresponding assumptions are 452, 0 and 0.76 tonnes, respectively.

48. It would be interesting to see the partial analysis used here more fully developed with better information from the authorities. A forward-looking analysis would also be appropriate: since the costs of the wind turbine subsidy are likely to fall if the green certificate system is successfully implemented, and the valuation of CO_2 is likely to rise, the results would almost certainly be more favourable to wind turbines.

3.3.2 Carbon trading in electricity generation

49. As noted earlier, the position of the electricity-generating sector is rather anomalous. A major emitter of NO_x and CO_2, it has been exempt from taxation on these (though a sulphur tax has been applied, as described earlier), and consumers pay an electricity tax unrelated to the fuel input (except that it is refunded to renewable sources). This may be explicable by the fact that electricity supply has been highly regulated and largely publicly-owned, so that it may have been felt that market signals would have little effect anyway. With the ongoing deregulation of this sector, economic instruments are being introduced. As from 2000 electricity generators will pay a CO_2 tax of DKr 40 per tonne *(i.e.* less than one-quarter of the value attributed to CO_2 abatement in the cost-benefit exercise summarised in Figure 3), but only if their emissions exceed a certain threshold (which is being reduced each year). (Table 3 takes no account of this tax.) The intended move to a tradable permit system – trading is planned to begin in January 2001 – will provide more effective incentives than the tax-threshold system because it provides a reward for reducing emissions below the threshold rather than only penalising the excess. The possibility that EU state aid rules might prevent the implementation of the scheme was removed when the European Commission approved it in April 2000. Having such a system in place will leave Denmark well prepared for the introduction of international CO_2 trading under the Kyoto protocol.

50. How efficiently all these taxes, subsidies and permits will achieve their environmental and other goals remains to be seen. The system is complicated and likely involve distortions that will, *a prior*i, mean excessive abatement costs in some industries and unjustifiably low abatement in others. Most of the CO_2 tax could be replaced by merging it with the cap-and-trade system currently planned only for electricity. Given the quantitative nature of the targets for SO_2 emissions, the SO_2 tax could also be replaced by a cap-and-trade system, though the authorities expect the SO_2 emissions to fall well below the target, on current policies. The major obstacles to such integration would be the carbon leakage or competitiveness problems discussed earlier, and also the possible loss of significant tax revenues. With SO_2 and CO_2 trading schemes in place, the green certificates would be unnecessary for wind turbines, provided either the permits were sold or auctioned by the government, or that an initial allocation were given to renewables producers.

51. One problem with both the green certificates and the CO_2 trading schemes may be how to deal with imported hydro-electricity from Sweden and Norway; the three countries already operate a common market in electricity, with Denmark typically importing hydro-electricity but exporting fossil-fuel generated electricity in years when precipitation has been too low to leave a surplus for export from Sweden or Norway.[30] The current intention is to allow only Danish "green" electricity generators to participate in the green certificate market. Such discrimination may be difficult under EU competition rules; the Danish authorities hope that these will be reconsidered in the near future with a view to allowing such restrictions.

30. This left Denmark with a definitional problem following the Kyoto negotiations. In the base year 1990, Danish imports of hydro-electricity were particularly large, and hence its emissions of CO_2 from fossil fuel burning unusually low, which means that the targeted reduction in emissions is more stringent than if 1990 had been a "normal" year. Danish negotiators have argued that emissions from exported electricity should be treated as being emitted by the country importing the power, but this has not been accepted.

3.3.3 Gas

52. The market for natural gas, in which Denmark is currently self-sufficient from North Sea supplies, is characterised by a very high degree of vertical integration[31] and an interesting approach to taxation. Up to 1996 taxation was in fact implicit rather than explicit, with prices being set (by regulation) as a function of the tax-inclusive prices of alternative fuel in any given market; this means that gas companies naturally charged the highest possible prices as opposed to the lowest possible prices to consumers (Economic Council, 1999). The resulting "shadow charge" generated implicit revenue of DKr 2¾ billion in 1996, equal to 11 per cent of all environmental and energy related taxes. If the alternative fuels were competing in a competitive market, with taxes set as a function of the environmental costs of those fuels, this might be quite a sensible way of extracting the resource rent associated with the gas, whose actual production cost is quite low and whose environmental externalities are below those of other non-renewable fuels. The implicit subsidy in the form of the special tax treatment of natural gas has made it possible for the distribution companies to service their debt obligations as a result of the rapid development of the natural gas supply network.

53. Since 1996 explicit tax charges on gas have been introduced, partly because the existing arrangements were incompatible with EU liberalisation, and the "shadow" tax revenue has more than halved. A more competitive natural gas market is planned as part of EU-wide liberalisation; as part of this, a move away from the policy of charging maximum possible prices could speed the substitution of gas for coal and oil, helping Denmark to reach its ambitious CO_2 targets.

3.4 Transport

54. A number of interesting questions arise in transport policy, both in the context of mass transit and automobiles. Public transport receives quite large direct subsidies and is not subject to certain environmental taxes, while private automobiles operate under a tax system which imposes very high fixed costs for car ownership, while the costs of car use are very similar to other western European countries.

3.4.1 Public transport

55. As in most European countries, train, inter-city and local bus services are subsidised, with subsidies generally covering a large part of total costs (Table 4). The aims of subsidisation are to keep down urban congestion, to ensure that a maximum number of people have access to public transport, and to help to reduce automobile use. In recent years there have been improvements in the efficiency with which public transport services are provided, with most services being provided by private contractors chosen by competitive tender and the level of services specified by the relevant county administration; as Table 4 shows, costs per passenger-kilometre travelled in deregulated buses are much lower than in trains, the latter mostly both state owned and operated. But full advantage has not been taken of these changes so as to allow market forces to increase economic efficiency and thereby improve environmental efficiency by internalising some of the environmental costs and allowing comparisons between costs and benefits.

31. The government owns directly Danish Oil and Natural Gas (DONG), of which Danish Naturgas A/S is a daughter company. Until the market opening on 1 July 2000 DONG-Naturgas has the sole concession on buying natural gas for the Danish market as well as a monopoly on transport and management of inventories. DONG-Naturgas, together with four regional municipally-owned companies, is also responsible for the sale and distribution of natural gas.

56. For example, the public transport sector in general is exempted from fuel taxes.[32] This means that efforts to improve fuel efficiency and thus reduce pollution depend on particular programmes to develop low-emission vehicles without giving operators any general incentive either to use such vehicles, or to reduce emissions by changing operating methods or the mix of vehicles used. Although a full bus produces lower emissions per passenger-kilometre than a typical car, when buses are far from fully loaded cars may have lower environmental costs – under some circumstances pollution could be reduced by switching from bus or rail to private cars, but there are no economic mechanisms to test for the advisability of such a switch.

Table 4. **Costs and subsidies in public transport, 1997**

Kroner

	Buses	Railways	
		State	Private[1]
Cost per passenger kilometre	1.61	2.03	0.39
Of which financed by subsidy	0.83	1.06	0.16

1. So-called private rail lines are in fact jointly owned by the state (70 per cent) and municipalities (30 per cent). They tend to be small lines in rural areas.

Source: Konkurrenceredegørelse (Competition Authority Report) 1999.

57. It might be worthwhile accepting higher pollution levels from running partially empty buses if these costs were offset by other benefits. For example, the social benefits of late-night rural bus services are an important factor used to justify subsidies. But little information is available on how valuable these social benefits are. The counties typically have no information on passenger numbers on any particular local bus route and apparently do not take such considerations into account when deciding whether to provide services or not. They are more likely to measure the value of a service according to how much protest arises when it is removed. Such a measure is certainly likely to be related to the social benefit - which may be of the nature of an option value: even though they may rarely use such bus services, people benefit from the knowledge that they can do so. If these arguments are thought to be important, surveys of passenger-use, and of potential use, would provide additional objective information.

3.4.2 Private cars

58. Denmark has very high taxes on private car ownership. The vehicle registration tax is levied at 180 per cent of the VAT-inclusive price over DKr 53 000 (at 105 per cent up to that price);[33] VAT is payable at the standard rate applied to the price exclusive of vehicle registration tax. In addition, an annual "pollution tax" is payable, at rates according to the tested fuel consumption of the model.[34] The pollution tax rises linearly (at DKr 460 per 0.5 litre per 100 km) for consumption above 5 litres per 100 km. The minimum rate is DKr 460 with fuel consumption at 5 litres per 100 km, but the tax rises more than proportionately with fuel consumption, increasing by a factor of eleven as fuel consumption doubles from the 5 litres per 100 km threshold. The taxes on motor fuels, however, are similar to those in neighbouring

32. According to the Competition Authority Report, of subsidies attributable explicitly to bus operators, approximately one-tenth were due to fuel tax exemptions (Konkurrenceredegørelse, 1999, p. 129).

33. The vehicle registration tax has been high in Denmark since the second world war, rather than as a result of concern in recent years about the environment.

34. This system was introduced for cars registered as from July 1997. The previous system, under which the tax was a function of the weight of the car, still applies for cars first registered before that date.

Germany. This is a deliberate policy, lest motorists avoid them by buying their fuel in Germany. According to Danish government estimates, switching of fuel purchases just by normal cross-border travellers *(i.e.* not taking account of any additional cross-border traffic that might occur) as a result of a significant fuel price differential between Denmark and Germany, would make such action prohibitively expensive for the budget (though good for the German budget). The national cost of increasing the petrol tax above the German level would thus be higher than the environmental benefit. The petrol tax and the annual pollution tax are slightly regressive, while the registration tax is progressive, as a higher proportion of the income of well-off households is used to pay this tax than for low-income households.

59. With such high taxes on ownership of private cars, it is not surprising that car ownership is relatively low, particularly when account is taken of the fact that incomes are relatively high – car ownership generally increases with per capita income (Figure 4). Figure 4 also illustrates, however, that total distances travelled by car in Denmark[35] do not appear particularly low, given average incomes. The implication is that cars are on average used more intensively in Denmark than in other countries – since user costs are no higher than typical European levels,[36] distance travelled is less out of line than the stock of cars. It is also likely – although firm data are not available to support this hypothesis – that the high fixed costs of ownership mean that cars are kept longer before being scrapped. If true, this would slow the rate at which innovations, including those improving the environmental performance of cars, are diffused.

60. The registration tax serves both environmental and more traditional revenue-raising purposes - its proceeds represented about 1½ per cent of GDP in 1998. The resulting high fixed cost of car ownership does have economic and social ramifications, however, since Danish households benefit less from the flexibility provided by car ownership than they would otherwise, with the effect likely to be concentrated in poorer sections of society.[37] Furthermore, the registration tax is not strongly related to most of the externalities from car use (most are proportional to fuel consumption or distance travelled), even if it does provide a strong incentive to buy cheaper cars, which tend to be lighter and have smaller engines, thereby reducing fuel consumption. However, removing the tax entirely might leave private cars facing a lower tax burden than the value of total negative externalities. Thus, the Danish authorities are considering the possibility of changing the base of the tax so that it would be more closely aligned with the many different source of externalities and not just incentives to buy cars with better fuel economy. Nevertheless, increasing the annual "pollution" tax would serve both to make up for lost revenue and to align car taxation better with environmental externalities. Gradually removing the exemptions for vehicles with only two seats (mainly for business use), which have no environmental justification, could also make up for lost revenue.[38]

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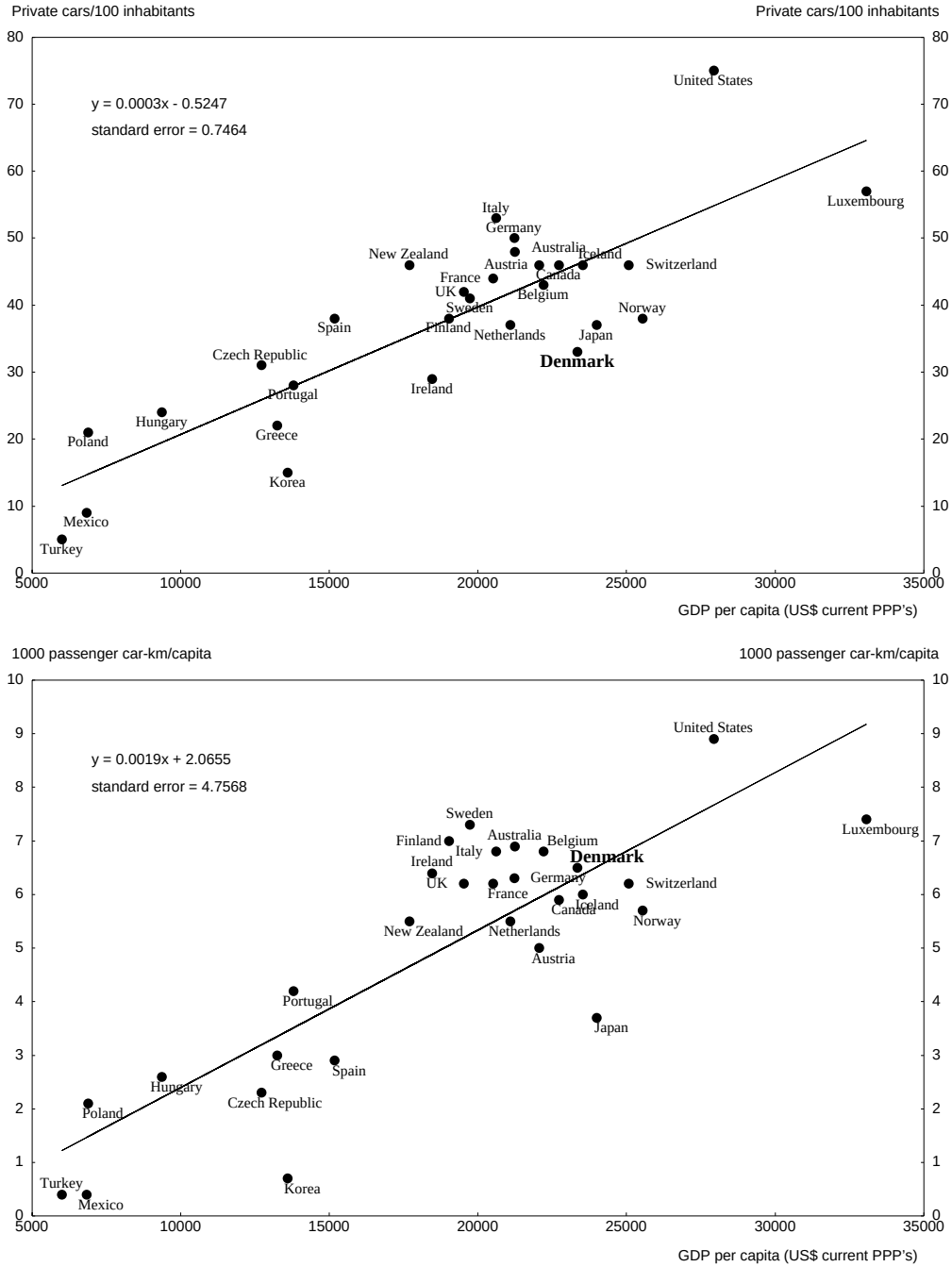
35. However, the Danish authorities argue that these data may be unreliable.

36. It could be argued that since depreciation of a car is partly a function of distance travelled, the high *ad valorem* registration tax acts to increase depreciation and hence the cost of car use. The strength of this effect depends on to what extent depreciation is actually perceived as one of the costs of car use, and how closely second-hand car prices are in fact related to distance travelled.

37. There are possible counter-arguments. The high cost of car purchase means that many fewer young people – including those who will later be well off – own cars than would otherwise be the case. Apart from higher use of (subsidised) public transport, bicycle use is also consequently quite high. It may be that this has resulted in a structure of endogenous "tastes" such that the demand curve for car use is shifted downwards. The reversal of such an effect, if it exists, by a significant reduction in the registration tax, might mean that the level of fuel taxes needed to keep traffic to its current levels might conceivably have to be so high as to have even "worse" distributional consequences than the present system. There appears to have been no empirical work in this area.

38. Another solution would be to increase fuel taxes in a graduated way, as a function of the distance from the German border, but administrative and political complexities probably rule this out.

Figure 4. Private car ownership and usage: an international comparison, 1996



Source: OECD, National Accounts and Environmental Data Compendium.

3.4.3 An integrated approach to transport and the environment

61. This section has only touched on two of the many issues involved in transport policy. But in both cases considerable costs are imposed, in one case on public finances and in the other on the household sector, by policies seeking to direct behaviour in certain directions because of social and environmental externalities. The two approaches to a large extent complement each other – making it costly to use private cars, and cheap and easy to use public transport – and thus may be thought of as part of an integrated transport policy. There is no real sign, however, of consistent integration of environmental externalities in the two sectors. Crudely, it seems as though the same quantity of pollution is treated as more costly when it is emitted by private cars than when emitted by public transport.

62. A better integrated approach need not imply, for example, eliminating "uneconomic" rural bus services. It may be perfectly rational to subsidise them, while taxing their use of fuel; the competitive tendering process would then have incentives to which to respond. (Indeed, if it is rational to impose a fuel-economy-related registration tax on private cars, it may well be rational to do the same for buses; as argued above, however, the rationale for this in the case of cars is not clear.) To achieve such integration effectively first requires identifying more explicitly both the positive and the negative externalities generated by different modes of private and public transport, and then quantifying them. Secondly, the structure of tax and subsidy needs to be aligned as closely as possible with these externalities. In the case of externalities generated by congestion, for example, neither a high registration tax nor a high fuel tax are necessarily the most efficient response; as technology permits it, road pricing may become a more important instrument.

3.5 Policy overview

63. It is often argued that as countries become richer, they tend to have cleaner environments, either because economic growth implies the use of more advanced, and therefore (so the argument goes) cleaner, technologies or because richer consumers demand a cleaner environment. It is certainly the case that Denmark, with one of the highest per capita incomes in the OECD, appears to have few acute environmental problems, though against a background of quite difficult-to-resolve air and especially water pollution problems. This relative absence of severe problems may be partly geographical and historical accident, with little heavily polluting industry – partly as a result of environmental policy – and few concentrations of population.

64. It is also true that Danish policy has recently adopted ambitious environmental goals, in some cases even when the environmental benefits will not directly accrue in Denmark. The most striking example is in the case of greenhouse gases, where both the unilateral target for 2005 and the target adopted in the EU burden-sharing agreement under the Kyoto Protocol for 2008-12 require an adjustment effort significantly greater than in most countries. It is true that there are indirect benefits from having a "green" image in the world community. In addition, even a self-interested policy could involve apparently altruistic behaviour, if it is part of a process of building and maintaining confidence in multilateral agreements with other countries.

65. Denmark has made increasing use of economic instruments and has gone further than most OECD Member countries, as reflected, for example, in the green tax reform of the early 1990s, which should reduce the economic costs of environmental policy. These instruments have so far been frequently applied as supplements to, rather than replacements for, command and control measures. One problem arises from the high degree of regulation and/or public ownership that remains in some key areas of the economy - notably in energy and transport. This means that while the economic instruments provide market signals, many of the agents in the market (public power and bus companies, for example, in the issues that have been discussed in this paper) are not always particularly constrained to follow them. To

achieve environmental goals it is thus often thought necessary to supplement the economic instruments with policy directives; hence, for example, in the case of waste, a system of taxes to encourage recycling has been introduced, but it is quantitative directives that seem to have the major impact on local waste management. Of course, even where this is the case, "green" taxes are useful sources of revenue, causing fewer unwanted distortions than the taxes they have replaced.

66. Furthermore, where the economic instruments seem likely to have a strong effect – that is where they may actually be costly to ignore – they are often overridden by special arrangements exempting particular industries or activities, on the grounds that they will impose heavy costs on them (especially those subject to international competition, as discussed earlier). Examples are the exemption of heavy energy users from taxes that should reduce carbon emissions, and of public transport from fuel taxes, as well as the very mild restrictions on nitrate emissions from agriculture. These policies result in highly unequal marginal incentives to abate pollution across different parts of the economy. Where the policy targets are relatively easily attainable, the costs of this inefficiency may be fairly low; this is less and less the case, however, as targets become more ambitious, and efficiency considerations need to be given greater weight. In general, worries over international competitiveness can be dealt with without distorting marginal incentives, although some of the solutions, such as "grandfathered" tax credits or emission permits, may mean sacrifices in terms of cost effectiveness or give rise to domestic competition worries if they act as entry barriers. Concerns over "leakage" and competitiveness may be used by industry pressure groups to argue for exemptions that are not justified on environmental grounds. Nevertheless, there may be occasions where a differentiated approach is justified, especially where action is taken unilaterally in anticipation of concerted international action.

67. One result of the willingness to deal with worries about competitiveness by practically exempting some of the most polluting industries is that final consumers end up having to bear a larger burden of any abatement than they otherwise would. Nitrate and carbon abatement policies are two examples, the implicit tax rates faced by households are many times higher than those faced by agriculture and industry in the respective cases. It might be argued that it is anyway the consumer who pays the final costs, whatever policy is adopted. However, loading many of the economic incentives onto the final consumption stage means that opportunities for input substitution or technical changes in the production process may be ignored. Furthermore, if economic instruments can be used to establish uniform prices and incentives for innovation, the apparent need to recycle tax revenues in the form of subsidies for technologies that may in truth be sub-optimal would be diminished.

4. Conclusions

68. Given the selective nature of this paper, the following cannot be a balanced assessment over the whole range of Danish environmental and natural resource policy, but draws conclusions from the previous discussion of the issues of water, waste, energy and transport. It also discusses the potential role of a more extensive use of explicit analysis of costs and benefits, where the points made certainly have an application wider than the particular issues or sectors included here.

4.1 Water

69. In dealing with water quality, as with all externalities, all sectors should ideally face the same incentives to reduce polluting discharges; the government has appeared reluctant, or unable, to impose this. Given the diversity of sources of nitrate and phosphate discharges, the main source both of eutrophication problems and, it seems, of deteriorating groundwater quality, complete uniformity is not achievable - measuring household discharges, let alone taxing them, is infeasible, to take one example. However, the steep increase in water charges and taxes over the last decade is indicative of the considerable costs that

cleaning water is imposing on the economy and therefore of the importance of dealing with it in a cost-effective way.

70. To this end, to the extent that water charges and taxes are imposed for environmental reasons, they should be set at similar rates on all users. Current rebates to industrial users or high rates for households do not seem to make sense, unless they are conditional on already removing pollutants that the taxes or charges are intended to deal with. It is better to correct the pricing structure directly rather than dealing imperfectly with it through differential taxes. Agriculture almost certainly has not been faced with appropriate incentives to reduce its nutrient discharges. The complicated biological and physical mechanisms at work make it difficult to assess what the marginal cost of reducing discharges would be, but the amount of information already available on farm-by-farm nitrogen balances, including inputs of both fertiliser and animal feed, would almost certainly support a scheme taxing estimated net discharges, or submitting them to a tradable quota scheme, with prices or quantities linked to the severity of the local water quality problem. If feasible, such a scheme should be less costly to farm output than the current plans simply to restrict fertiliser use to a certain proportion of the "optimum". A simpler though less well targeted approach would be to tax fertiliser (or, again, use tradable quotas). Ideally, similar conditions to those set for agriculture should apply to freshwater fish farming, whose exemption even from current restrictions is surprising.

71. Under a taxation scheme, the problem may arise that the costs to farmers (ultimately to landowners) may be very high. As in other cases, the appropriate response is not to start with low tax rates, but to offset some or all of the burden through tax credits, or through issuing "grandfathered" quotas without charge. Any such arrangements could reasonably be transitional, implementing the polluter-pays-principle by phasing out tax credits, or moving to auctioned quotas.

4.2 Waste

72. In the area of non-toxic waste disposal, Danish policy has developed quite a strong system of economic instruments, with differential tax incentives for recycling, incineration with or without co-generation of electricity and heat, or landfill, along with a cost recovery principle covering operational costs. If these taxes are thought to represent the social and environmental costs of the different methods of disposal, it should be possible to phase out the constraints of national targets for the proportion of waste recycled, which do not make sense if environmental externalities have been suitably internalised. This is especially so when set at a national level because such targets are unable to take into account collection, transportation and processing costs that may vary both by location and through time. Economic instruments allow such costs to be taken into account, and thus might result in levels of recycling higher in some areas, lower in others. But allowing waste taxes alone to regulate the treatment of (non-hazardous) waste requires an explicit assessment of the cost of associated externalities. Agreement on these may be more difficult to achieve in practice than agreement on quantitative targets. It is also the case (though this is not in itself an argument against recycling incentives) that regulations requiring recycling of glass bottles, with specific restrictions on the kind of bottles allowed, and banning metal cans as drinks containers, by some are claimed to be protectionist measures disguised as environmental ones.

73. Denmark also has a range of taxes on individual containers and packaging products, as a function of the product and material used. When set in line with environmental costs, such taxes are highly appropriate. Some proposed aspects of this system of individual taxes have been modified on the grounds of excessive administrative complexity. It is worth monitoring the costs and benefits of the operation of this system, in order to improve its working in Denmark but with the useful externality of providing information for other countries on their advantages and disadvantages.

4.3 Energy

74. Energy policy and taxation have been discussed extensively in this paper. From the point of view of the targets for *Danish* emissions of greenhouse gases, energy taxation appears distorted, and the renewables programme, now largely based on wind turbines, seems to have incurred costs much higher than any environmental benefits achieved so far (the innovative green certificate system will substantially reduce the cost of the wind turbine subsidy for any given target, however). However, the two greenhouse gas targets – that self-imposed for 2005 as well that agreed for 2008-12 in the EU burden-sharing agreement under the Kyoto Protocol – are more ambitious than those for many countries, and were partly designed with the aim of encouraging other countries to make greater efforts.

75. The result is a set of policies that, while using economic instruments, does not minimise the costs of reaching the targets, except when those are defined to exclude reductions due to activities that may be displaced abroad. Activities where the loss of output in reducing GHG emissions is likely to be the lowest are taxed relatively lightly and receive subsidies to finance profitable investment, while other activities are heavily taxed. It is true that if all sectors paid the same tax rate, some industries might suffer cost increases sufficient to close them down, resulting in distributional outcomes that might be considered to be unfair. This would have three principal consequences: loss of capital, loss of jobs and "leakage" abroad of GHG-intensive activities.

76. For a given emissions-reduction target, both job destruction and loss of capital (through reduced profits) will be greater if a differentiated tax rate is introduced.[39] Concern over losses due to falls in the value of emission-generating capital is best dealt with through a temporary compensatory scheme, which might take the form of tax credits or allocation of emission permits by "grandfathering"[40] Such schemes would probably not eliminate the need for job losses,[41] but by minimising overall output reductions they are likely to minimise any shrinkage in employment as well.

77. However, "grandfathering" would not deal with concern over the environmental cost of emissions leaking abroad: since marginal incentives remain the same as for a uniform tax, firms' behaviour would be unchanged, at least in the long run. Hence, in the case of leakage lowering the tax rate does have some beneficial effect – emissions of GHG and other pollutants abroad are reduced. Furthermore, where leakage is likely to occur only in the short run, ending when other countries implement their own GHG-abatement programmes, such action may prevent an industry closing down unnecessarily and possibly permanently.

78. Whatever the conclusion on the latter, within the electricity generating industry itself there is room for more efficient policies than the current or imminent combination of wind turbine subsidies, obligations to purchase renewable energy and CO_2 trading. Since the environmental benefits of wind-generated electricity are largely reduced emissions of SO_x , NO_x and GHGs, consideration should be given to replacing the green certificate programme by integrating tax and trading arrangements for all these emissions across all generators. The resulting output of "renewable" electricity may fall below the 20 per cent target but the only loss in this case would be in security of supply. It would be useful for the

39. This is the case, except to the extent that the burden on direct energy use by final domestic consumers is increased. In this case job losses will be fewer; but welfare would fall too as the incentive to reduce households' indirect consumption of energy is reduced.

40. This is true provided that the distribution of tax credits or emission permits is not a function of actual or future emissions. In Sweden such a compensatory scheme is used in the NO_x charging system.

41. Unless the CHG-intensive companies are better able to generate jobs in other activities than the average company.

government to explicitly identify the risks against which wind turbines provide such security, in order to assess the most cost-effective way of ensuring it.

4.4 Transport

79. This paper has not covered the whole range of transport policy but has touched on idiosyncrasies in two areas: subsidies to public bus services and vehicle taxation. Transport is an interesting case because subsidies to public transport are sometimes justified on environmental grounds, yet badly designed subsidies can lead to excessive environmental costs when passenger loadings are too low. In such a situation, cost-benefit studies are necessary, but they are conspicuously lacking, perhaps because basic data are frequently not available. Allocation of these subsidies is the responsibility of county authorities and it would appear they have insufficient incentive, or perhaps insufficient information, to improve or optimise the use of the funds. Since both the costs and benefits are local, it would not be sensible for central government to impose a uniform subsidy policy on the counties, even though most finance for county and municipal policies comes from block grants or earmarked taxation. Regardless of whether the overall benefits of these subsidies exceed costs or not, encouraging, perhaps mandating, systematic cost-benefit analysis of them, and of other subsidies, would be helpful. Such analysis should include considering how best to deliver subsidies, in particular how to internalise environmental costs. Ending the exemption from fuel taxes would be one obvious step.

80. Just as environmental considerations (among others) may justify subsidies to public transport, so they may justify taxation of private transport. In Denmark, private cars are subject to a very high level of taxation. Since most of the relevant environmental externalities are related to car use rather than to possession, the very high vehicle registration tax is not very effective as an incentive to reduce externalities for those who possess cars, but appears to reduce car ownership significantly. The authorities accept this but argue that the alternative – higher fuel tax – is ruled out by the impossibility of raising fuel taxes in Denmark significantly above those in neighbouring countries.

81. Again, some cost-benefit analysis is required to clarify matters. The high fixed costs of car ownership produce a burden on car owners, who tend to be wealthier. However, for any given type of car, the burden on the poor is greater. This may in turn generate pressure for subsidies to public transport which in principle can be measured. The simple cross-country regression presented in this paper at least suggests that although the high fixed costs result in relatively low levels of car ownership, distance travelled per person is not obviously lower than in other countries, even when income levels are taken into account. Potential costs from a lower turnover of the stock of cars, and hence a higher average age, which means that embodied technological improvements in environmental performance are incorporated later than elsewhere, should also be taken into account.

4.5 Assessing costs and benefits

82. Many aspects of Danish policy towards natural resources and the environment have advanced in the direction of improving cost efficiency during the 1990s. In particular, there has been increasing use of taxes and charges in a number of areas – SO_2 emissions, waste and water pollution, for example. Politically it was convenient that many of these changes began as part of general tax reform efforts to reduce marginal income tax rates. The efficiency improvements in adopting such approaches are largely independent of so-called double-dividend gains, however. Further extensions should be pursued and need not depend on this justification. Revenue-neutral schemes or even those that may reduce overall revenues may be appropriate in some areas: they should not be ruled out *a priori.*

83. Ideally environmental taxes should be set equal to, or at least as a consistent function of, the value of likely environmental damage arising from the taxed activity. Generally this has not been done. This is partly because it is not easy to get such information. However, the approach adopted has been to set taxes according to some estimate of the impact of taxes on the level of the tax base - targeting a particular reduction in the damaging activity; those targets are often set according to an international agreement or EU directives, with which Denmark has to comply. Measuring success according to whether this target is just met, or over- or under-achieved, then comes naturally but is partly mistaken, depending on whether the target made sense in the first place. It may well be that a targeted decline in a polluting activity is achieved, even if the tax is set beyond its optimal level; conversely, the tax may well have been optimal, even if the reduction in polluting activity had been less than anticipated.

84. To assess the overall efficiency of these targets, or to assess outcomes, one needs much the same kind of information on the value of damage as is needed to set the "optimal" tax in the first place. The Danish authorities should undertake more systematic research to quantify the costs of environmental damage: to enable taxes to be set more coherently, but, perhaps even more importantly, to set more efficient policies in the areas where a "command and control" approach is retained. This need not always imply doing fully original research each time – shadow prices and costs should not generally change from one context to another, and results from other countries can be useful. It may be difficult to establish definite social valuations for many things – a range of values may be the nearest it is possible to get. Using such information to establish bounds on benefits and costs is still better than having no such information at all.

85. Some things cannot easily be quantified or valued (for example, where what may be thought of as "rights" may be concerned). Consideration of these may sometimes reasonably overrule a quantified cost-benefit analysis: yet even in these cases, such analysis is useful, in particular because it is likely to increase transparency and consistency in decision-making. The Danish authorities, notably in the Finance Ministry and in the Ministry of Environment and Energy, have started programmes of work to assess costs and benefits of policy, notably in the areas of waste, waste water, air pollution and traffic. The results will no doubt help to implement further improvements in the integration of Danish environmental and economic policies.

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