SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Denmark's energy sector is a microcosm of many of the major energy issues facing IEA countries today. These include very proactive government policies in renewable energy and energy efficiency, advanced market reform of the electricity and gas sectors, market power's effect on competition, fossil fuel production and issues related to reserve depletion, and a very challenging greenhouse gas (GHG) reduction target. However, it is Denmark's pioneering role in renewable energy and energy efficiency that allows it to provide particularly valuable lessons for other countries. For this reason, the 2006 *In-depth Review of Danish Energy Policies* has placed particular emphasis on these two issues.

Denmark's emergence as a leader in the renewable energy sector represents a remarkable transformation. Despite lacking almost entirely in hydroelectric resources and without the strong biomass tradition of its Scandinavian neighbours, the government has used policies to build up one of the biggest renewable energy sectors in the world. Renewable energy supply more than doubled from 1992 to 2003 when it accounted for 13.4% of total primary energy supply (TPES).[1] The figures for electricity generation are even more pronounced. In 1991, renewable energy accounted for only 3.1% of domestic electricity generation but in the 12 years to 2003, that share grew more than sixfold to 19.0%. The preliminary figures show substantial further growth in 2004 when renewables' share rose to 25% of total electricity generation.

Renewable energy brings numerous benefits to Denmark. Renewables are generally emission-free, resulting in substantially lower GHG emissions. In 2004, renewables reduced carbon dioxide (CO_2) emissions by 6.5 million tonnes of CO_2 ($MtCO_2$), or about 10% of that year's emissions. Such reductions are particularly important for Denmark, which faces a very challenging Kyoto target. Renewables also contribute to security of supply since they are a domestic resource that represents supply diversity. While this is not an immediate concern in Denmark given its oil and gas reserves, it will become increasingly so as those reserves are depleted. In addition, the Danish renewables industry, benefiting substantially from government policy, is now the world leader in wind turbine manufacturing, creating substantial employment and export revenue.

1. 2004 figures, while still preliminary, show an additional 8.5% increase in renewable energy supply to account for 15% of TPES.

At the same time, the government's renewable support policies did not come without a cost. The above-market payments for electricity generated from renewable sources are recovered from electricity customers as a component of the Public Service Obligation (PSO), a levy placed on every kilowatt-hour (kWh) of electricity sold in Denmark. In 2005, the renewable component of the PSO was approximately 5.4 øre[2] per kWh on every kWh of electricity sold in Denmark. This surcharge was equal to approximately 3% of the household consumer's final bill when all taxes and grid charges are included, and approximately 9% of the electricity bill for businesses.[3] Danish customers directly paid a total of DKK 2 088 billion in 2004 to support renewable energy. This is equal to around 0.2% of the country's gross domestic product (GDP) or DKK 390 per person. As a percentage of the total wholesale price payment, it is substantial, equalling approximately 20% of the payment for the purchase of wholesale electricity to meet Danish demand.

Apart from the direct subsidy payments from customers, there are additional costs resulting from the government support for renewables. These mainly involve interference with the competitive dynamics of the electricity market. Any type of government influence, which favours certain technologies over others, will decrease market efficiency. Mandated must-run plants of a certain technology, size and timing make the electricity system less efficient and thus more costly to run. One cost resulting from wind power is the stress on the transmission system, which can result in economic inefficiency. Such costs are the inherent consequence of added renewable capacity and need to be compared with the benefit of renewables in the light of other energy policy objectives.

Taking a narrow view of renewables policy by considering just the most easily measured benefit (GHG reduction) and the most easily measured cost (direct subsidies from consumers), costs of supporting renewable energy, to date, are not justified. Estimates from the Danish Economic Council and the Danish Energy Agency, as well as independent analysis by the IEA, show that the cost of reducing each tonne of CO_2 emissions has historically been substantially higher through renewables than could have been achieved through other domestic programmes, such as energy efficiency, or through international mechanisms. The estimates conclude that the historical cost of reducing each tonne of CO_2 emissions through renewables policies of the 1990s was roughly between EUR 35 and EUR 50 per tonne. This is well above the current (and forward) price of emissions in the EU Emissions Trading Scheme (EU-ETS) and well above the assumptions on the cost of emissions reductions assumed

2. On average in 2005, one Danish krone (DKK) = USD 0.1668. (1 DKK = 100 øre.) This rate will be used for any conversions performed in this report. The krone is closely tied to the euro.
3. The figure is higher for businesses because their electricity prices are lower owing to lower taxes and lower grid charges than households.

when formulating the country's climate change strategy. Nevertheless, trends in the relative cost favour renewables. Improving technology and greater operational experience will continue to lower their costs while competing energy prices are likely to rise.

Other factors should also be considered beyond this narrowly defined analysis. Perhaps the most relevant is the decreasing cost of renewables over time. The Danish Energy Authority (DEA) has calculated that all-in costs of onshore wind turbines fell from around 10 eurocents per kWh in the 1980s to 7.5 eurocents per kWh in the early 1990s to 4.9 eurocents per kWh in 2004 and will drop to 3.7 eurocents by 2020. Such advances not only make any future renewable supports more attractive but also vindicate previous support policies to a degree since they clearly had a role in accelerating the cost reductions. In addition, as market prices for electricity rise, comparative prices for renewables, paid through either feed-in tariffs or a capped premium, are less costly for Danish consumers. In addition, the price for CO_2 reduction allowances in the EU-ETS, as well as for oil and gas, could rise thereby making renewables more attractive.

While renewables can enhance energy security given their domestic nature, they can also diminish security, at least in the case of wind, which has a highly intermittent generation profile compared to fossil fuel plants. While Denmark has been successfully dealing with wind intermittency and integrating greater shares of wind power into the system, it relies heavily on its hydro-rich neighbours and its strong connections with the continent to do so.

While such a debate on renewables is instructive and can inform future decisions, given the current rate of renewable penetration, the existing capacity in operation and the well-established renewable (wind) industries, there is no going back on Danish renewables policy. Nevertheless, it is crucial for current policy-makers to shape future policies based on cost-effective analysis of past and ongoing policies to get the most from renewable energy while minimising its disadvantages.

The current government is very attentive to cost-effectiveness and inclined to market-based approaches in promoting renewable energy. The new premium system combined with market prices is a positive step to incorporate market elements into the support framework. The current support level is lower than in other countries guaranteeing prices. However, the transitional arrangement offered by the government through the previous feed-in tariff may, in certain cases, create over-subsidisation. To reduce this problem, the government has moved to the capped premium and its gradual reduction depending on the year of installation. The most recent premium applied to the plants from 2005 is 12.3 øre per kWh without any cap. While this will make the possibility of over-subsidisation less likely, depending on the pace of cost reduction of wind turbines, carbon prices and oil/gas prices, there could be a situation where

the wholesale market prices are sufficient for cost recovery without any such premium. This possibility suggests how difficult it is to ensure an appropriate support level through administratively determined prices (or premiums).

Green certificates, which are priced according to the difference between the market price and production cost could theoretically solve the problem of over-subsidisation. Green certificate systems are relatively new and the experiences in other countries are mixed. Transitional challenges would arise changing from the current mix of support schemes. However, certificate schemes would in theory induce long-term cost reductions through direct competition of renewable facilities of all technologies. Denmark could learn from other countries' experiences, including Sweden, the United Kingdom and Australia.

The new offshore wind is supported by the tendering system. By incorporating competitive elements, this system offers a more market-oriented approach than the past feed-in tariff scheme. On the other hand, consistency between the tender approach, whereby the government mandates a large quantity of a particular technology and the liberalised Nordic market's, as well as the government's basic position to let the market pick up new capacity, needs to be observed.

The other area where Denmark plays a pioneering role is in energy efficiency. Denmark's energy intensity is the lowest in the European Union (EU). Although it is 35% below the IEA average, the government continues to seek improvement through an ambitious new efficiency programme. This impressive record on efficiency has come from a concerted effort by the government and not from any inherent characteristic of Denmark itself. Among other measures, the government has put in place stringent building and appliance codes, public service campaigns on energy use, a public sector that sets an efficiency example, an extensive combined heat and power (CHP)/district heating (DH) network, high taxes on energy and negotiated agreements with industry. Furthermore, these and other efficiency measures have in no way detracted from the country's quality of life or economic performance; Denmark has both a higher GDP per capita and lower unemployment than the EU-15 countries on average. While countries have different demand profiles (influenced largely by the presence of energy-intensive industry), Denmark provides a good example of the benefits of government-induced energy efficiency.

Many of the benefits of greater efficiency are the same as the benefits of renewable energy, notably GHG emissions reduction and enhanced energy security. In addition, both renewable energy and energy efficiency can and should, at least to a certain degree, benefit from government programmes that support them more than a purely free market would. While there is no basis to treat renewables and energy efficiency as mutually exclusive goals, it is worth noting their relative cost-effectiveness in meeting essentially the same goals.

On the basis of the available evidence from Denmark, energy efficiency programmes have been significantly more cost-effective so far than renewable energy programmes in reducing GHG emissions and enhancing energy security. Evaluations of the Electricity Savings Trust, an efficiency group funded by a special surcharge, indicate that the cost of reducing CO_2 through its efficiency programmes is around DKK 55 (EUR 7.38) per tonne. The Association of Danish Electricity Distribution Companies, which also carries out efficiency work, reports that its efficiency efforts in 2003 resulted in CO_2 emissions reductions at a cost of DKK 40 (EUR 5.37) per tonne, while in 2004 its efforts were entirely cost-effective based on the value of suppressed demand and thus correspond to a GHG emissions reduction at no cost.

These results favour efficiency but come with two caveats. One, they represent just a snapshot of the costs and benefits of these programmes. Both technology and energy prices can change significantly over time, thus altering the relative attractiveness of efficiency and renewables. The second caveat concerns the methods of assessing efficiency programmes. The figures cited above from the Electricity Savings Trust and the electricity distribution companies are derived from the groups themselves and thus might be subject to a degree of bias. In addition, there is understandable uncertainty as to how different efficiency measures should be valued. Nevertheless, given the apparent cost-effectiveness of the efficiency measures and the renewed government push in this sector, it would be extremely beneficial if the government developed an objective methodology for assessing the costs and benefits of its efficiency programmes.

The current government efficiency programmes are more market-oriented than previous schemes. One of the major avenues for demand reduction will be through the electricity distribution companies. Each company is allocated a certain amount of demand reduction that they must achieve but will be free to do this in whatever way they wish. The money they receive to realise this demand reduction is fixed and thus they have incentives to reduce costs rather than propose expensive new programmes. The companies can even buy and sell demand reductions among themselves as a means of concentrating efforts in the most efficient locations. These more market-based measures are commendable and likely to increase the cost-effectiveness of these efforts. The biggest possible obstacle will be the complexity of the system and determining standard ways to measure savings realised by each efficiency programme. The government should ensure that such a methodology is in place as soon as possible, striving for simplicity whenever possible, and consulting the experiences of other countries with similar programmes, notably the UK.

One area conspicuously absent from government efficiency programmes is transport. The political agreement initiating the new efficiency push explicitly excludes transport from its purview. This is unfortunate since transport represents 33% of final consumption and is showing the fastest energy

growth in Denmark. While curbing energy demand in transport is a challenge for all IEA countries, a number of measures could be introduced in Denmark. For one, the currently high registration tax (easily surpassing 150% of the ex-tax price) could be graduated according to the efficiency of the vehicle, as yearly registration fees already are. In addition, the high registration tax and normal petrol tax (by EU standards) penalises car ownership rather than actual use. A reconsideration of these incentives may lead to ways to reduce demand without altering the total combined taxation on cars and fuel. Denmark could also consider expanding the scope of voluntary agreements to freight industries. Both Finland and Japan have introduced innovative agreements with freight and other road transport groups.

The district heating sector also offers untapped opportunities to improve efficiency. The sector is currently regulated with cost-plus tariff methodology, which has a poor record in inducing cost reductions or efficiency. Some form of benchmarking should be introduced to set standards for costs so that outliers can be identified. In addition, a number of larger cities, notably Copenhagen, have or will have two or more heat suppliers feeding the heat pipeline system and therefore some measure of managed competition could be introduced there. Another area for improving the heating system is the mandatory participation of all consumers with access to district heating. Such controlling behaviour can stymie new products and/or other forms of innovation.

Denmark has been progressive in reforming its gas and electricity markets. As a member of Nordpool, it belongs to one of the most competitive and transparent electricity markets in the world. For the gas sector, it offered right of supplier choice to all customers in January 2004, three years before the requirement in the EU directive. The legal and regulatory parameters of the competitive market are sound. However, the merger between Danish Oil and Natural Gas (DONG) and the country's two major electricity generators and distributors raises market power issues that could impede competition and raise prices for consumers. The new company would have a dominant position in electricity generation in both east and west Denmark; own most of the electricity and natural gas distributors; and have partial operational control of gas storage.[4] Moreover, this consolidation is taking place at a time when there are already reports of increased electricity prices, which cannot be explained by standard market competition.

Some of the motivation for the DONG merger is a fear that the unmerged companies would be too small to fend off unwanted takeovers from larger foreign companies. While some countries have responded to this threat with

4. The European Commission, in its 16 March 2006 conditional approval of the merger, required that DONG sell the larger of its two storage facilities, Lille Torup in Jutland.

the type of consolidation taking place in Denmark, such as Austria, others have been largely indifferent to the nationality of their utility owners, such as the UK and the Netherlands. Proponents of the merger also argue that Denmark's extensive international connections make discussion of market power on a national basis irrelevant and that any measure of market concentration should take place on a European level where the merged DONG company would remain a modest player. In addition, Denmark has instituted full legal and partial ownership unbundling. Nevertheless, the new DONG will have such a degree of horizontal and vertical integration across the entire energy sector that it is very likely to be able to exert market power in a non-competitive fashion at certain times throughout the year. This is especially true in light of plans to partially privatise DONG in the coming years, thus ceding some control to a company or individual shareholders whose sole objective is profit maximisation. The government and the regulator are encouraged to thoroughly explore all means by which the new DONG could profitably raise prices and vigilantly investigate any instances where this might have been done.

RECOMMENDATIONS

The government of Denmark should:

General Energy Policy

- *Review energy and environmental taxation as a whole to establish more targeted and efficient price signals to achieve energy policy objectives, such as security of supply, environmental protection and the economic production and consumption of energy.*

- *Monitor the energy market carefully in order to take concrete steps to minimise the implications that the horizontal, vertical and cross-fuel integration in the electricity and gas markets resulting from the merger activity, particularly the foreseen DONG merger, will have on competition in the Danish energy markets.*

Energy and Climate Change

- *Take further account of the compliance risk of an insufficient supply of Joint Implementation (JI) and Clean Development Mechanism (CDM) credits being available within the envisaged price range as well as the availability and price of allowances under the EU-ETS.*

- *Address the competitive implications of the emissions reduction obligations of sectors included under the EU-ETS.*

- *Investigate further domestic cost-effective measures to reduce emissions in sectors not covered by the EU-ETS.*

- *Further investigate solutions to the possible double-burdening of CO_2 emissions by EU-ETS and Danish CO_2 and energy taxes.*

- *Address the windfall profit issue for covered installations that are benefiting from free receipt of European Union Allowances (EUAs) through the EU-ETS.*

Energy Efficiency

- *Continue implementation of the ambitious energy efficiency targets which can bring greater energy security, reduced CO_2 emissions and greater national competitiveness.*

- *Continue to perform further cost-benefit analyses as part of this implementation to assess the efficacy of individual efficiency measures.*

- *Clarify the concept and details of the "market-oriented" system imposed on distribution companies to achieve energy savings; consider the examples of countries implementing or planning "white certificate" or energy efficiency obligation programmes, such as Italy, France, the Netherlands and the UK, and the administrative costs involved as the system becomes more complicated.*

- *Clarify the measurement parameters of the efficiency programmes engaged in by the distribution companies, the Electricity Savings Trust and other groups to be able to better assess the efficacy and progress of such programmes; be aware that the planned review of these programmes in 2008 provides only a modest time to judge and thus requires clearly defined parameters.*

- *Implement a control and follow-up enforcement of the new energy regulations for buildings by all levels of government to ensure that the energy efficiency requirements are really achieved.*

- *Introduce measures to improve transport energy efficiency by addressing the following issues, among others:* i) *the current registration tax to ensure it differentiates on efficiency and does not keep older, inefficient cars in the fleet,* ii) *a tax system that penalises vehicle use rather than ownership, and* iii) *use of voluntary energy savings agreements.*

- *Investigate whether load-shifting measures can be introduced together with efficiency measures to shave demand from costly peak times and/or to make the demand profile more consistent with the Danish supply profile.*

- *Explore opportunities to induce greater efficiency in the district heating (DH) sector through performance benchmarking, incentive-based rate-making or some form of competition*

- *Ensure that DH regulations regarding obligatory participation and tariff structures with high fixed components do not impede efficiencies such as introduction of new appliances and new technologies, greater insulation and behaviour modification.*

- *Investigate the prospects of energy efficiency coming from private-sector energy service companies (ESCOs).*

Renewable Energy

- *Make greater use of cost-benefit analyses to assess the worth of various government support schemes for renewables.*

- *Continue the development of market-based approaches for any increased use of renewable energy, ensuring that caps and other measures limit the possibility of over-subsidisation.*

- *Closely monitor the impact of the tendering system for offshore plants on the functioning of the liberalised electricity market.*

- *Continue to take initiatives and co-operate with local authorities to overcome siting difficulties of wind turbines, including test facilities.*

- *Analyse the green certificate systems in other countries.*

- *Ensure that all power plants, particularly wind, pay their share of transmission upgrades needed to serve their new generating additions.*

Electricity

- *Continue the work to improve the market framework for the use of demand-side response in day-to-day energy trading as a way to enhance market efficiency and as an alternative mechanism to reserve margin management.*

- *Review the arrangements applying to the use of electricity in district heating to improve commercial market incentives to use electricity at times of high production and low price.*

- *Ensure that objective cost-benefit analyses drive investment decisions for the network.*

- *Provide a more stable operational and investment planning framework for the removal of transmission bottlenecks through market linked regulatory incentives on the transmission system operator.*

- *Work towards the harmonisation of regulatory instruments across countries participating in the Nordic market and Germany.*

Fossil Fuels

- *Maintain a policy supporting an open and competitive investment climate in the exploration and production sector.*
- *Maintain a tax policy in the exploration and production sector favourable to investments in new technologies and new recovery methods to prolong the life of the existing fields and produce new discoveries.*
- *Consider the effects of gas reservoir depletions on security of supply as well as possible medium-term responses such as enhanced connections with other North Sea gas infrastructures, the possibility of connecting to the Russian fields (through the North European Gas Pipeline project) and liquified natural gas facilities.*
- *Ensure that objective cost-benefit analyses drive investment decisions for the gas transport network.*
- *Ensure that all companies, whether incumbents or new entrants, are given true equal access to storage facilities and that this in no way becomes a barrier to competition.*
- *Evaluate whether a gas release programme for domestically produced gas might induce new suppliers into the market and thus facilitate more competition.*

Energy Research, Development and Demonstration

- *Continue the recent trend of increased government spending in energy RD&D activities.*
- *Ensure that energy RD&D continues to be consistent with domestic energy policy to support Danish industries in order to extend their success in the international market.*
- *Continue to ensure that transformations in the energy sector, most notably the creation of Energinet.dk from existing electricity and gas transmission companies, and the DONG acquisition of Elsam A/S and ENERGI E2, do not result in decreased or disrupted RD&D activity in the relevant sectors.*