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SUBMISSION TO THE STERN REVIEW ON THE ECONOMICS OF CLIMATE CHANGE[1]

Renewable Energy is widely believed to have a significant role in tackling climate change. However, the Renewable Energy Foundation judges that the extent and character of this role is often misunderstood, even in governmental circles, with the result that policy is structured around expectations which are both unrealistic and likely to encourage deployment of renewable energy in ways which are sub-optimal. Our purpose in responding to the call for evidence is to urge that the Review's analysis draws upon the experience of our European neighbours, who have made extensive experiments aimed at reducing emissions via the means of renewable energy technologies.

To bring these matters into sharper focus, the Foundation has commissioned a brief report from Dr Wolfgang Pfaffenberger, Professor of Economics (European Utility Management) at the International University of Bremen, and Director of the Bremer Energie Institut.[2] This report is included in the body of our evidence, and will be separately published elsewhere.[3] We very much hope that the Review will think it appropriate to call Professor Pfaffenberger, and indeed other European experts, as viva voce witnesses.

Professor Pfaffenberger indicates that German endeavours with regard to emissions reduction, particularly via renewable electricity, have been unsatisfactory in a number of regards, a fact which is now increasingly widely recognised in Germany itself (the list of references in this report will, we believe, be of considerable importance to the Review).

Professor Pfaffenberger's report may be summarised as follows:

1. Subsidy support for renewable technology in Germany has encouraged the production of renewable energy, but it has sheltered renewables from the disciplines of the market, resulting in unbalanced development. In Professor Pfaffenberger's words:

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[1] Submitted to Stern Review, 2nd Floor, Room 35/36, HM Treasury, 1 Horse Guards Road, London SW1A 2HQ, Email: callforevidence@sternreview.org.uk, in response to the call for evidence on http://www.hm-treasury.gov.uk/Independent_Reviews/stern_review_economics_climate_change/sternreview_index.cfm.

[2] http://www.iu-bremen.de/directory/02826/

[3] www.ref.org.uk

> *To promote market introduction would require that renewable energy producers regularly become responsible for marketing their product by themselves. It would require that they produce the balancing services necessary for a marketable product and combine these services with their renewable product. The present system is clearly a system where the renewable energies are outside of the market whereas on the other hand of course they influence the market.*

We believe that this comment applies with equal force in the United Kingdom, where the Renewables Obligation has the superficial appearance of a free market instrument, but has created an artificial, indeed a "hothouse", situation, with all the undesirable results that such a forced growth entails.

2. Renewable electricity is, relative to other means, an expensive method for the reduction of greenhouse gas emissions. (We note that this empirical experience confirms the findings of the National Audit Office report on *Renewable Energy* published earlier this year, [4] and also endorses the views expressed in the House of Lords Report, *The Economics of Climate Change*[5]) Professor Pfaffenberger writes:

> *Whereas the promotion of renewables in Germany was definitely effective in the sense of increasing capacity and production it was certainly not cost effective in the sense of getting the highest effect per Euro in terms of greenhouse gas reduction or production from renewable sources.*

This is a very important conclusion, and we will comment on further on this matter below and in our final remarks.

3. Because of difficulties in balancing the grid due to the presence of stochastic wind generation Germany is now faced with the need for costly and largely unanticipated measures to ensure stable supplies. These increases in cost have implications for industry, as Professor Pfaffenberg indicates:

> *A system of national support for renewable energy in the way the German system has been designed definitely changes the competitive position of any industry that works for the international market.*

There is no compelling evidence that the situation in the United Kingdom is significantly different. Indeed, in-so-far as the UK's grid is islanded, as opposed to being richly interconnected as is the case in Germany, balancing problems and associated costs are more probable here (for comments on this matter we refer the Review to the articles by Hugh Sharman in *Civil Engineering*,[6] discussed below. Furthermore, in some respects

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[4] National Audit Office, *Department Of Trade and Industry: Renewable Energy*, report by the Comptroller and Auditor General, Hc 210 Session 2004-2005, 11 February 2005. Available from http://www.nao.org.uk/

[5] House of Lords Select Committee on Economic Affairs, *The Economics of Climate Change*, July 6th 2005, Chaper 5.

[6] Hugh Sharman, 'Why Wind Works for Denmark', *Proceedings of ICE: Civil Engineering*, 158 (May 2005), 66-72; and 'Why the UK should build no more than 10 GW of Wind Capacity', *Proceedings of the Institution of ICE: Civil Engineering* 158 (November 2005), 161-169.

the regulatory framework in the UK is less favourable to industry. For example, Professor Pfaffenberger writes that while intensive energy users in Germany are granted partial exemption from the impact of renewable energy laws, cost increases have still resulted in a crisis in these industries. In the United Kingdom, of course, far from being sheltered to any degree, industry is exposed to increased costs via both the Climate Change Levy and the Renewables Obligation.

4. The introduction of renewables has not necessarily had a positive net effect on the economy. In a crucial passage Professor Pfaffenberger writes (the emphasis is ours):

> *Part of the motivation for promoting renewable energy is to substitute local generation for imported energies and in this way promote economic activity and employment. A number of studies have been carried out during recent years to investigate the effects of the promotion of renewables in this respect.*
>
> *The results are not very encouraging (see Häder, 2005 and Hillebrand, 2005). Basically, of course, investing in renewable energy plants creates employment in industries producing these investment goods. On the other hand the extra cost of renewables adds to the cost of energy and in this way destroys purchasing power that otherwise could have created demand and indirectly employment in other areas.* ***Whereas the gross effect of spending money on renewables is always positive, the net effect may be negative.***

We draw attention to this last point because it bears with considerable weight on the way in which the United Kingdom conceives of renewables within its climate change policy. Any climate change policy which is economically deleterious for the proposing state will fail to encourage emulation at international level, and thus will fail as a climate change mitigation policy, since it is only by carrying the developing world in the direction of lower emissions that a domestic policy can achieve significance. The United Kingdom emits roughly 550 million tonnes of CO_2 per year.[7] This is roughly 2% of the global total of 24,000 million tonnes.[8] It should be immediately apparent that the United Kingdom has no quantitative role in global climate change policy, but instead can only contribute by:

- Demonstrating and exporting good practice
- Providing an economically compelling example.

Rapid growth in the developing world further emphasises this point, and may be conveniently indexed via electricity. China is at present approximately five times the size of the UK electrically, with an installed capacity of roughly 357 GW, generating approximately 1,800 TWh.[9] The UK has an installed capacity of roughly 74 GW and

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[7] For latest emissions data see DEFRA: http://www.defra.gov.uk/environment/statistics/globatmos/gaemunece.htm

[8] Current estimates can be obtained from the Energy Information Administration of the US Dept. of Energy: http://eia.doe.gov/.

[9] See International Energy Annual data on: http://www.eia.doe.gov/emeu/iea/

generates around 400 TWh per year. By 2020 it is estimated that China will need to generate some 11,000 TWh, with an installed capacity of approximately 2,400 GW.[10] **In other words, by 2020 China will have grown sixfold electrically and be some 30 times the size of the UK in this sector.** While nuclear and hydro-electrical power will provide a considerable portion of this energy, the bulk is expected to come, necessarily, from coal and gas.

Seen against such backdrop, it is obvious that the United Kingdom climate change and energy policies will be at best futile unless they are *economically* attractive and sufficiently practical to induce emulation in China. Consequently, as we have emphasised in our 2005 Manifesto,[11] it is essential to recognise that the goals of the 2003 Energy White Paper must be prioritised correctly, even though this resequencing may seem counterintuitive.

It is widely agreed that energy must demonstrate favourable credentials in a number of areas, and ideally should be:

- Secure
- Reliable
- Economical
- Clean
- Sustainable

However, it should be noted that these are qualities which should be characteristic of the overall energy portfolio. It is not enough that the various component technologies of our portfolio should demonstrate them individuall. Each technology must manifest these qualities in such a way that:

- The ability of other technologies to deliver their benefits is not impaired.
- The value of the energy sector as a whole is not seriously compromised.

We suggest that the criteria should be arranged in the sequence given above, reflecting their priority and consequence. The logic of this sequence can be explained as follows:

- If security of the primary sources cannot be guaranteed, then reliability at the point of use is questionable;
- If security and reliability of supply are compromised, then our economy will be damaged;
- If our energy supplies are insecure, unreliable, and unaffordable we will be unable to maintain and develop the high technological economy necessary to

[10] See statements by Zhang Guobao, vice-minister of the National Development and Reform Commission quoted in the *China Daily*, 19 Oct. 2004: http://www.china.org.cn/english/BAT/109757.htm

[11] Manifesto 2005, *Renewable Energy – the Need for Balance and Quality,* Published by the Renewable Energy Foundation, January 2005

support our social aims and control the emissions of a large urban and industrial society.

- If the energy system in its total sense is unclean, as is seen in the CIS countries and parts of the developing world, then our social aims will be compromised by ill health in our population.
- And finally, if we cannot achieve any of the foregoing aims, our overall energy policy will be unsustainable, and the well-being of the United Kingdom and its people will be poorly served in the short, medium, and longer term.

This sequencing and logic differs radically from that found in the *Energy White Paper*, which we believe is gravely and dangerously flawed.[12] In particular we note that the *White Paper* foregrounds emissions abatement as the principal goal, and allows other goals to settle into subordinate positions in no particular order. In criticizing this policy framework, the Renewable Energy Foundation is not suggesting that emissions abatement is unimportant, but, rather, that placing it centre-stage is likely to compromise our ability to reach other essential objectives.

In the light of this we are drawn to conclude that the Renewables Obligation has created sub-optimal investment patterns in renewable technologies, and that significant revision, learning from the experience of Germany and Denmark, is required. We refer the Review to the many publications revealing evidence from Denmark and Germany now confirming that wind energy is at best a fuel saver, and offers only a very low "capacity credit" (the ability to replace "firm" capacity in the portfolio). We recommend that the Review is mindful of both the E.ON Netz *Wind Report 2005* and the recent articles in *Civil Engineering* by the leading energy consultant, Hugh Sharman.[13] (For the convenience of the review team, and with Mr Sharman's permission, we are submitting copies of these articles together with this document.)

From these documents, and from Professor Pfaffenberger's report for us, we conclude that the UK's current policy is heavily over-dependent on wind energy. This imbalance is largely the result of the simplistic structure of the Renewables Obligation, which is "unbanded", and makes no distinction between the manifest merits of various technologies. The consequence has been an investment scramble for the least capital intensive ticket to the RO subsidy stream (initially land-fill gas, now wind), regardless of the intrinsic value of the technology adopted. This is doubly unfortunate, since the overemphasis of one technology has resulted in the neglect of others, such as tidal and biomass systems, which have more offer in terms of secure and firm energy provision. While wind power will undoubtedly form part of the UK's future portfolio, the current

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[12] See, for example, *Energy White Paper: Our Energy future: Creating a Low-Carbon Economy* (Dti: London, 2003), pp. 7ff.

[13] REF's abstract of the E.ON report is available from www.ref.org.uk, and the full report http://www.eon-netz.com. Hugh Sharman's papers, 'Why Wind Works for Denmark', *Proceedings of ICE: Civil Engineering*, 158 (May 2005), 66-72, and 'Why the UK should build no more than 10 GW of Wind Capacity', *Proceedings of the Institution of ICE: Civil Engineering* 158 (November 2005), 161-169.

levels of proposed development, particularly in Scotland and Wales, are, from a national perspective, irrational and do not constitute a wise use of scarce capital.

Conclusion

From the above analysis we conclude that there is no *necessary* conflict between the two major goals of any UK energy policy:

- Configuring energy provision to serve our own economic needs, and
- Fulfilling the United Kingdom's international responsibilities in relation to climate change.

Indeed, **if the energy policy promises economic disadvantage it will by the same token be ineffective as a climate change policy** because it will fail to carry the developing world in the same direction. Thus, we conclude that:

> **Economic viability and attractiveness is the first and fundamental test of any climate change policy for the United Kingdom.**

John Constable
Director of Policy and Research
7 December 2005

Appendix 1. Report to the Renewable Energy Foundation by Professor Wolfgang Pfaffenberger, Bremer Energie Institut, International University of Bremen.

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RENEWABLE ENERGY POLICY IN GERMANY:

EXPERIENCE AND PROBLEMS

A Short Survey for the Renewable Energy Foundation

Bremen

6 December 2005

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1. The Renewable Energy Law

The present policy of promoting renewables in Germany has various roots:

- Conflict about the nuclear energy program (the last 3 reactors were connected to the grid in 1989),
- beginning awareness about the necessity of reducing greenhouse gas emissions and, also to some extent
- the idea of substituting imported energy by domestic investment and production.

In the present scheme of support substantial quantities of money are being transferred without any contribution from the government budgets of the federation, the states or local governments. The payments made to generators of various types of renewable energy are based on a fixed price paid to those generators for, usually, 20 years, depending on the amount of energy produced and many specific factors (type of energy, type of production plant, location of plant etc.). The payments considerably exceed the present wholesale market price for electricity and thus give producers a very good basis for evaluating investment plans. Also, in addition to the fixed payment, sales to the grid are guaranteed and grid operators have to give absolute priority at all times to any renewable energy offered.

Hence the two most important market risks for any producer selling products to a market, namely quantity risk and price risk, are being reduced to zero for suppliers of renewable energy.

The prices set by the legislator are based on what is deemed necessary for certain types of renewable energy plants. This, of course, poses a strong information problem, and there is a strong incentive for renewable energy producers and their associations to act strategically as far as prices are concerned.

In order to compensate for the lack of market elements in the promotion scheme the legislator has introduced an element of price reduction for future years. The prices set by the renewable energy law decrease from year to year by a certain percentage but these new prices only apply to plants built in that year. A plant built in 2005 receives the price for 2005 for 20 years. A plant built in 2006 receives the price for 2006 for 20 years and so on. Thus there is a strong incentive to build now and not to build later. The transfer of money is institutionalized in the following way: grid operators measure the amount of renewable energy fed into their grid and at the end of a year this is summated. On that basis the so called quota (share of renewable energy in relation to total final consumption of electricity) is calculated and grid operators pay renewable energy producers the amount of money that they are entitled to receive according to the law. It will be apparent from this mechanism that the average price of a unit of renewable energy is calculated *after* the end of the year. All electricity suppliers then have to pay the grid operators an amount of money based on the (fictitious) amount of renewable energy that they have received (quota multiplied by their consumption) and based on the average price of renewables that had been calculated by the grid operators. In this way all the monies paid to renewable energy producers at the end is paid by electricity consumers. This is the economic side of the game.

The law also provides a kind of physical fiction. In order to make sure that the payments made from suppliers to grid operators could not be considered to be just a transfer of money without any corresponding product flows, all customers of electricity receive, theoretically, a share of renewables with their power delivery that corresponds to the average share calculated for the country as a whole. Why is this fiction? The inflow of electricity from renewables sources (particularly wind energy) is based on natural factors and not at all controlled by demand. Therefore, grid operators must obtain substantial quantities of balancing power to transform the irregular renewable energy generated into a product structure that corresponds to the structure of demand.

This grid operator service is not part of the money transfer connected to the renewable energy law but is paid by the grid operators and part of their network fees. As considerable amounts of money maybe involved, this, as a matter of course, increases the fees in the transmission network relative to other European countries where such a system does not exist.

The aim of the renewable energy law is to promote the production and use of electricity from renewable sources, and it is often said that the subsidies promoting renewables are necessary to promote the market introduction of these products. However, the present system however does not really encourage market introduction. What it really promotes is the production of renewable energy. To promote market introduction would require that renewable energy producers regularly become responsible for marketing their product by themselves. It would require that they produce the balancing services necessary for a marketable product and combine these services with their renewable product. The present system is clearly one where renewable energies, though outside of the market, are nevertheless able to influence the market (for more on this see below).

2. Development of Renewable Energy and Remuneration

Tables 1 to 3 in the annex show the results of the renewable energy law. The quantity of renewable energy produced with financial support through the feed-in law has increased considerably and is expected to increase much further in the coming years. Of the total, two thirds is wind energy, a proportion which is expected to remain roughly the same.

Regarding the average price paid for a unit of renewable energy Table 2 shows that it has risen continuously in recent years. This is true for the price per unit and also for the sum total, as can be seen from Table 3. Renewables cost about 4.5 billion Euros per year in 2005 and this sum is expected to grow to about 9 billion Euros in 2011.

These figures include all monies that producers of renewable energy receive, and thus they represent the cost of renewables at the point of feed-in into the transmission grid. The extra cost of necessary backup measures is not included in this figure. On the other hand renewable energy replaces other fuels used for the generation of electrical energy. Hence, the financial savings in the cost of fossil fuels replaced has to be taken into account. As most of the renewables run against medium load plants one can assume that they replace mainly coal. The coal price at present is around 6 Euro/MWh and this adds a value to renewable electricity of about 16 Euro/MWh. Taking this into account, the net cost of renewables to the economy was around 1 billion Euros in 2000 and will rise to about 7.5 billion Euros by 2011.

Making the generous assumption that every kilowatt-hour from renewable sources replaces 1 kilogram of CO_2 the quantity of CO_2 avoided expressed in millions of tonnes is the same as the production figures in Table 1. Thus in 2011 renewables could be expected to replace about 90 million tonnes of CO_2 emissions. On the other hand, if a renewables replace natural gas fuelled generators, then the amount of CO_2 avoided would be considerably smaller due to the lower carbon emissions of that plant (the CO_2 emission from a highly efficient natural gas plant is about 400 kilograms/MWh versus 1,000 kg in an average coal plant).

What is the cost of reducing CO_2 emissions with renewable energies in the German system? Dividing the net cost of renewable energy by the amount of the CO_2 emissions avoided the cost for a tonne of avoided CO_2 is around 80 Euro/tonne. Thus it becomes apparent, that abating carbon dioxide emissions by renewable energy in the electricity sector is a relatively expensive way of greenhouse gas reduction.

3. Problems of Renewable Energy Policy

3.1 Integration of Renewables in the Network

The emphasis on wind energy in German policy towards renewables was highly successful in the sense of increasing the number of installations and the installed capacity, but is now creating a lot of follow-up problems that were not thought of originally. Figure 1 (see annex) shows the production of wind energy plants in Germany, Figure 2 shows the installed capacity by states and Figure 3 shows the average load factor of wind energy plants as approximately 17.1%. The following can be seen:

1. The regional concentration of plants in the North-West areas of Germany (Lower Saxony: Niedersachsen, Schleswig-Holstein, Brandenburg) leads to problems in the regional networks. The transmission system in Germany has been built with a generous capacity reserve in order to cope with regional disturbances without interfering with the quality of supply in the system as a whole. The system is based on a relative close proximity to production and demand. With the high regional concentration of wind energy plants in coastal areas with low population density the power generated has to be transported over longer distances. This requires capacity additions in the high voltage transmission grid.
2. In general this puts the total transmission system under stress because of the volatility of wind energy. As can be seen from figure 3 the average contribution to

load by wind energy plants is relatively low, but this contribution is unevenly distributed over the year. The contribution maybe high at times of low demand and maybe low or zero at times of high demand. In this respect a certain conflict arises between using the transmission grid for European power trade (that is transportation of electricity planned by suppliers and producers) and spontaneous fluctuations generated by wind energy plants which are given priority and thus can override planned transport in the grid. (Source: information from the Ministry of Economy and the Union of Power Producers). This disequilibrium also shows up when we look at the capacity of wind energy plants relative to their production. The peak load in Germany at present is about 77 GW, and the total capacity of wind is about 22 % of this peak load. The electrical energy consumption of Germany is presently about 483 TWh, of which wind energy contributes about 5 %.

Two measures are necessary now to secure system stability:

1. Keeping backup capacity in the background to compensate for fluctuations in wind energy.
2. Improving the network to create additional reserve capacity in the network to cope with extreme fluctuations and solving the long distance transport problem.

Both problems have cost implications and will be discussed in the next section. The implications of an increased contribution of renewable energy of a volatile nature for a system as a whole have been extensively studied in the so called Denas study (*dena Studie)*, a joint effort of the network operators and the operators of renewable energy plants and the Government.

3.2 Cost of Renewables

The additional cost of renewables was shown in Chapter 2. Whereas the promotion of renewables in Germany was definitely effective in the sense of increasing capacity and production it was certainly not cost effective in the sense of getting the highest effect per Euro in terms of greenhouse gas reduction or production from renewable sources.

- System integration causes additional cost through necessary backup (reduced efficiency of coal-based generation due to more idle hours, increase of overall capacity due to low load factor of wind energy plants etc.).
- Additional cost for strengthening and extending the high voltage transmission grid (in the first phase 450 kilometres have to be strengthened in a later phase almost 1,000 kilometres (source: *dena Studie*)). The financial implications of this additional investment are relatively low in relation to the overall investment in the production system, but there is growing resistance from the population against new high voltage transmission lines in their neighbourhood. There is now a growing demand to build high voltage transmission lines as underground cables. There is no real long-term experience with long-distance

underground cables for high voltage transmission. Recent estimates for a concrete project in the North-West of Germany (Ganderkesee–Diepholz) show that the total cost for an underground cable may be about five times higher compared to a typical power line, even if all the benefits of the earthbound cable (lower losses, lower repair cost etc.) are also included (see Forwind, 2005).

All these cost factors add to the network fees charged by the transmission grid operators.

The energy intensive industries are particularly prominent in complaining about recent increases in power prices. Power prices have gone up due to several reasons:

- Increased prices of primary energies.
- Increased share of renewables, with associated costs.
- Increased prices in the transmission system due to the necessary extra efforts to stabilise renewable energy and maintain a high level of backup power for wind energy.

Energy intensive industries are partly exempt from the renewable energy quota and its contribution to the power price. A system of national support for renewable energy in the way the German system has been designed definitely changes the competitive position of any industry that works for the international market. Although there has been an exemption from part of the cost of renewable energy this exemption only relates to a small number of industries and also is limited to a certain ceiling which, however, will probably be reached as soon as 2006. Until now the legislator has not been willing to fully exempt energy intensive energies (Aluminium smelters, chemical plants etc.). This has lead to a recent crisis in these industries. (Pfaffenberger et al, 2005).

Energy prices are subject to taxes as well. In addition the newly introduced European trading scheme for CO_2-certificates has added to the power price. The different instruments created to influence power production with the aim of reducing greenhouse gases are not all consistent. The average final household customer pays an implicit CO_2 tax of about 30 Euros per tonne (when one relates the power tax to the average CO_2 content of electricity). This tax is rising with the share of renewables that avoid CO_2. In addition the consumer pays the price of CO_2-certificates that are contained in the wholesale price of power since 2005. Ultimately, the consumer has to pay for the promotion of renewable energies. The details can be seen from Table 4. The contribution to renewables is still relatively small but as has been shown in chapter 2 it will rise enormously in forthcoming years.

3.3 EFFECTS ON THE ECONOMY

Part of the motivation for promoting renewable energy is to substitute local generation for imported energies and in this way promote economic activity and employment. A number of studies have been carried out during recent years to investigate the effects of the promotion of renewables in this respect.

The results are not very encouraging (see Häder, 2005 and Hillebrand, 2005). Basically, of course, investing in renewable energy plants creates employment in industries producing these investment goods. On the other hand the extra cost of renewables adds to the cost of energy and in this way destroys purchasing power that otherwise could have created demand and indirectly employment in other areas. Whereas the gross effect of spending money on renewables is always positive, the net effect may be negative.

4. Conclusions

1. Expenditure on greenhouse gas reduction should be effective.
2. Support for renewables has several different dimensions. While the technological dimension is important and needs funding, renewables which are approaching market-readiness should be increasingly handled with more market-oriented approaches.
3. Renewables are not alone in being able contribute to energy supply and greenhouse gas reduction in the production of electricity. There are also other carbon-free alternatives available (carbon-free nuclear, or carbon sequestration from fossil fuel, for examples). Furthermore, renewables are not limited to electricity and can offer interesting contributions in the market for heat and in the transport sector.
4. There is a limit to integrating renewables that feed their power stochastically into the grid. Evaluation of this option has to consider the full cost including backup power and network enhancement.

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6. Annex: Tables and Figures

TABLES

Table 1: Power from renewables promoted by feed-in law.[15]

	Total	**Hydro**	**Gas**	**Biomass**	**Geoth.**	**Wind**	**Solar**
	GWh	GWh	GWh	GWh	GWh	GWh	GWh
2000	**13,854**	5,486	-	780	0	7,550	38
2001	**18,145**	6,088	-	1,472	0	10,509	76
2002	**24,970**	6,579	-	2,442	0	15,786	162
2003	**28,496**	5,874	-	3,469	0	18,859	294
2004	**38,511**	7,205	-	5,241	0	25,509	556
2005	**45,447**	7,711	147	6,993	0	29,593	1,002
2006	**49,287**	7,674	377	7,999	30	31,969	1,238
2007	**55,149**	7,780	580	9,868	70	35,190	1,660
2008	**61,120**	7,882	651	11,881	140	38,501	2,065
2009	**68,926**	7,987	723	13,798	223	43,759	2,436
2010	**78,645**	8,126	763	15,538	358	51,147	2,714
2011	**90,901**	8,292	801	17,586	567	60,729	2,927

Note: Hydro includes gas until 2004. Gas: added production from 2005 on.

Table 2: Share of renewables and average price

	Total consumption	Privileged consumption	Renewable power from sources promoted by law	Share (2)	Average price
	[GWh]	[GWh] (1)	[GWh]	%	[ct/kWh]
Prognosis for 2005	483,886	60,633	45,447	10.5%	9.5
Balance 2004	487,627	36,865	38,511	8.5%	9.3
Balance 2003	478,016	6,552	28,496	6.0%	9.1
Balance 2002	468,321		24,963	5.3%	8.9
Balance 2001	464,286		18,145	3.9%	8.7

Definitions:
Share: Share of renewable energy promoted by feed-in law in total final consumption of electricity.

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[15] Source for this and following tables: VdN (Union of Network operators). Data until 2004 are actual results, data for 2005 onward are projections.

Average price: Weighted average of feed-in prices. This is the basis for payments that suppliers have to make to grid operators.

Notes:

(1) Privileged consumption of large industrial users with reduced contribution.
(2) Share for non privileged consumption.

Table 3 Remuneration of renewables according to feed-in law in millions of Euros

	Total	Hydro	Gas	Biomass	Geoth.	Wind	Solar
2000	**1,177**	395	0	74	0	687	19
2001	**1,576**	441	0	139	0	956	38
2002	**2,225**	476	0	231	0	1,435	81
2003	**2,604**	425	0	325	0	1,709	144
2004	**3,611**	519	0	508	0	2,300	282
2005	**4,422**	555	10	687	0	2,662	506
2006	**4,887**	555	25	808	4	2,859	634
2007	**5,566**	561	39	994	9	3,129	831
2008	**6,233**	568	44	1,189	18	3,401	1,010
2009	**7,025**	576	48	1,367	28	3,837	1,165
2010	**7,933**	586	51	1,523	44	4,451	1,276
2011	**8,802**	599	53	1,705	68	5,018	1,356

Note: Hydro includes gas until 2004. Gas: added production from 2005 on.

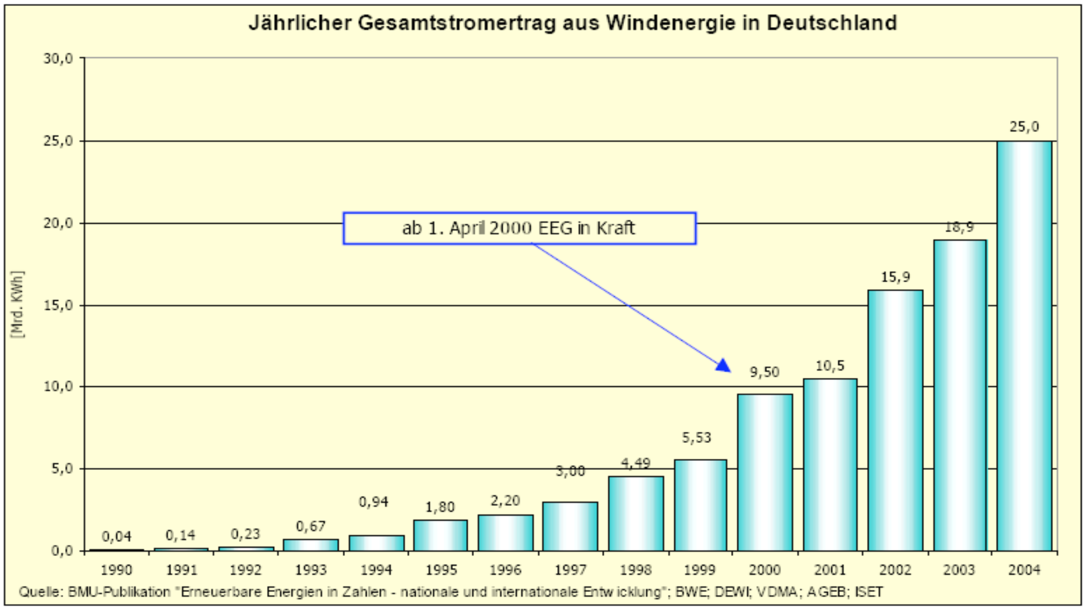
Table 4: Environmental policy and residential power price in €/year

Renewables (0,87 c/kWh)	26
Power Tax (2,05 c/kWh)	75
CO_2 charge (valued at 20€/tonne)	60
VAT (16%)	26
Total	**187**

Source: Author's estimation for household with consumption of 3,000 kWh/year

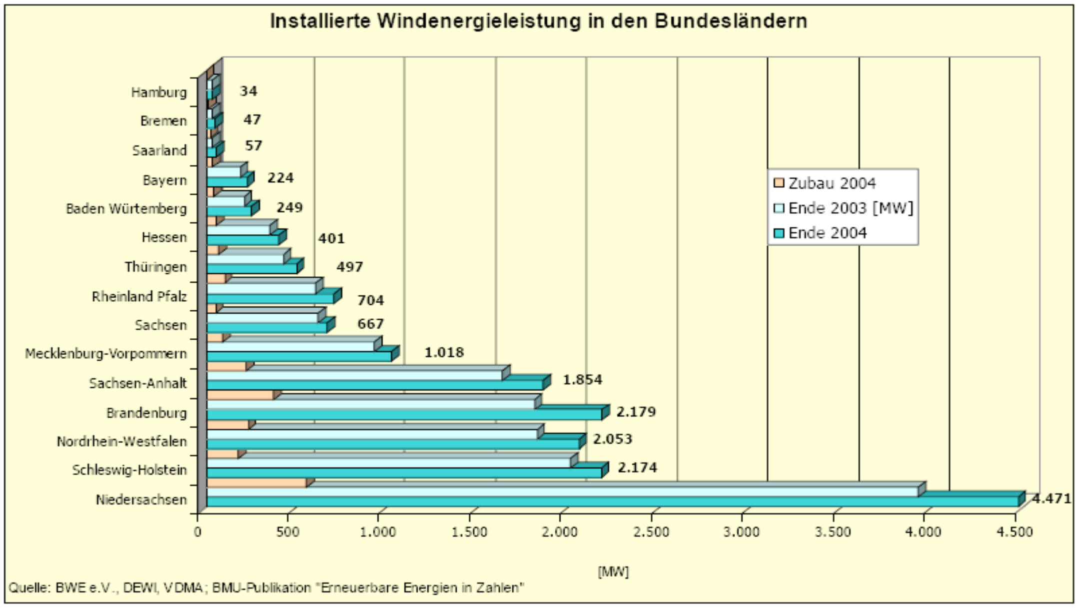
FIGURES

Figure 1: Wind Energy Production Germany[16]



[16] Figures 1 and 2: www.erneuerbare-energien.de. Information published by the Federal Ministry of the Environment.

Figure 2: Wind Energy Plants by State (MW)



Total German capacity at end of 2004: 16,629 MW. Brown columns show capacity added in 2004, other columns total capacity in 2003 and 2004 respectively.

Figure 3: Contribution of wind energy to electricity (Source: see figure 1 and 2)

Total production 2004:	25 Bill. kWh
Total capacity 2004:	16,629 Mill. kW
Average use:	1,500 h/year approx

Note: Average use is equivalent to Load Factor, i.e. 1,500/8760 = 0.171