Wind Energy: Facts and Fiction

A half truth is a whole lie

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About the Author:

J.A. Halkema (M.S.E.E.) is an authority on the subject of energy. A retired electrical engineer, after graduating from the Technical University in Delft he worked for the international company Brown Boveri Nederland, now Asea Brown Boveri (ABB). He was associated with widely diverse uses of electrical equipment, ranging from electrical traction materials to switchgear and transformers from 3 kV up to 380 kV. He also had ongoing contact with testing laboratories throughout Europe. In his capacity as an Executive Board Member, he was responsible not only for sales but for the design, manufacture and testing of medium-voltage switchgear.

Publications:

- ***Windmolens: Fictie en Feiten*** **(Quantes)** **ISBN 90 7509 572 4**
- ***Windmolens? Zinloze machines!*** **(Quantes)** **ISBN 90 5959 015 5**
- **(*Manifest Windenergie*** **(Quantes)** **ISBN 90 5959 028 7**
- ***Ellende door windmolens in Duitsland*** **ISBN 90 5959 033 3**
  (*Condensed version of the German E.ON Wind Report 2005*)
- **Critique of *Wind Power and the UK Wind Resource* (published by the Oxford Environmental Change Institute, University of Oxford) (Published in Energy & Environment, Vol. 17, No 4, 2006)**

Over the past several years, dozens of newspaper and online articles have recorded the author's activities and his stance against the misleading information regarding the characteristics and capabilities of wind turbines as producers of electricity for national use. He maintains that wind energy advocates with hidden political and monetary agendas intentionally withhold vital information from the public.

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Introduction

Electric power is a cornerstone of any country's economy and standard of living. The uninterrupted availability of electric power, from second to second all year around, determines every opportunity associated with that economy and living standard. Most people take for granted that electric power is generally always at hand with unfailing reliability, unaware that complex technical measures and the disciplined co-operation of many large interconnected power stations are necessary to achieve and to maintain that situation.

Fervent discussions and enthusiastic articles about new ways to produce electric power currently abound. And wind energy in particular features in these alternatives for a sustainable production of electricity, especially in the light of global environmental concerns. It is remarkable, however, that the most important information concerning the factors necessary for a reliable consumer supply is almost always withheld. Like the fact that all the properties and inherent disadvantages of wind turbines are caused by one single law of physics, a Law of Nature. That is the law that determines the kinetic energy of wind as being the source of the driving force of wind turbines: $\mathbf{E = f.\ m_{spec.}.v^3}$
This is the reason that you will continuously be confronted with this formula when its miserable consequences for wind turbines come up in this dissertation. Some of these unpleasant but unavoidable consequences are: its minuscule but always unpredictable kilowatt-hour production, the hundreds of equally randomly occurring variations and power interruptions in the course of a year and resulting form all this, the risks for a save operation of the grid and the minute substitute of wind energy for conventional electricity production

These matters and some more of which little is written or spoken by promoters of wind energy will be discussed. Showing how much is downright kept concealed or even made looking better by showing statistics that are contrary to reality. Such as a misleading graph of an average of the uncontrollable varying kilowatt production of wind turbines over a certain period instead of the reality of hundreds randomly sharp varying power between zero and maximum.. (See the figures 1 and 2 further on)

This of course does not mean that new ideas about the production and competitiveness of alternative sources of power generation are unwelcome, but the limitations and disadvantages should never be hidden intentionally. Indeed, one must resist attempts to gain any kind of personal advantage, whether financial or political. Disturbing is that for many promoters of wind energy the sole motivation seems to be to garner strongly subsidised contracts for the construction of wind turbines, or at least to acquire a laudable 'green' image. The world is facing acute energy problems. In the light of steadily growing concerns, the public should not be told that a partial solution has already been found and is working well. That claim is blatantly untrue.

This treatise is intended to provide enough information to enable the reader to distinguish between facts and fiction, between sense and nonsense, regarding wind energy and wind turbines. The reader should not be confused or intimidated by the many numbers presented here. The truth can often only be demonstrated successfully by measured or directly measurable integers. This is true in particular with regard to wind energy. You will frequently come across a reference to that formula $\mathbf{E = f. m_{spec}. v^3}$ because that is the gist of the whole truth about wind energy. You will also meet some explanations similar to those given in previous or later sections. The repetitions are intentional.

Because of its highly accurate and educational nature, I refer often to the excellent ***Wind Report 2005*** from E.ON, a large German electricity company that operates no fewer than 7000 wind turbines. This report offers a clear and concise insight into the almost unsolvable problems caused currently in Germany by the extensive use of wind energy.

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Wind power or wind energy

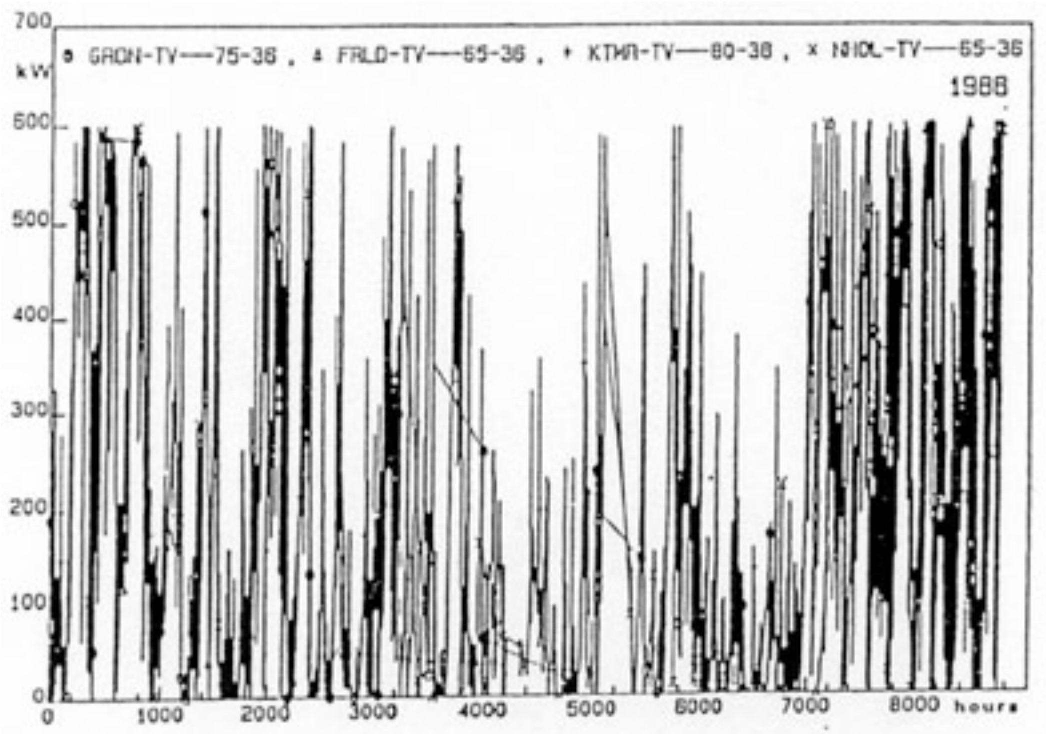
The reason why I have chosen to use the term Wind Energy instead of Wind Power in the title is because most publications from promoters of wind energy use the word Power (the kilowatts) to conceal the essential fact that the Energy (the kilowatt hours) produced by wind turbines is negligible and without any 'security of supply'. This is explained in the next chapter. For consumers of electricity the energy is of prime importance.

$E = f.m_{spe}.v^3$. The kinetic energy of wind

The kinetic energy of the wind is the source of the driving force of a wind turbine.
That kinetic energy can be depicted by the formula $\mathbf{E = f.\, m_{spec}.v^3}$
In this formula:
E = the kinetic energy
m_{spec} =the specific mass (weight) of air
v = the velocity of the moving air (the wind)
f = a calculating factor without any physic meaning

That specific mass of air is extremely low: 1.18 kg/m^3
The velocity of the wind is, technically speaking, also very low
This shows that the kinetic energy of wind can only be small. And because of that third power (the cube) of the velocity **v** it can only be extremely variable when the speed of the wind changes.
The term v^3 indicates that it is impossible to predict the power that drives the propeller of a wind turbine. For that reason it is equally impossible to forecast the number of kilowatts that will be produced at any given moment, or the number of kilowatt-hours during a certain period. Likewise, a prediction of the production factor/capacity factor of a wind turbine is impossible. It will always be guesswork.
It is clear that the behaviour of the kinetic energy of the wind is the source of all the miseries relating to the use of wind turbines. Without any exception.

Figure 1

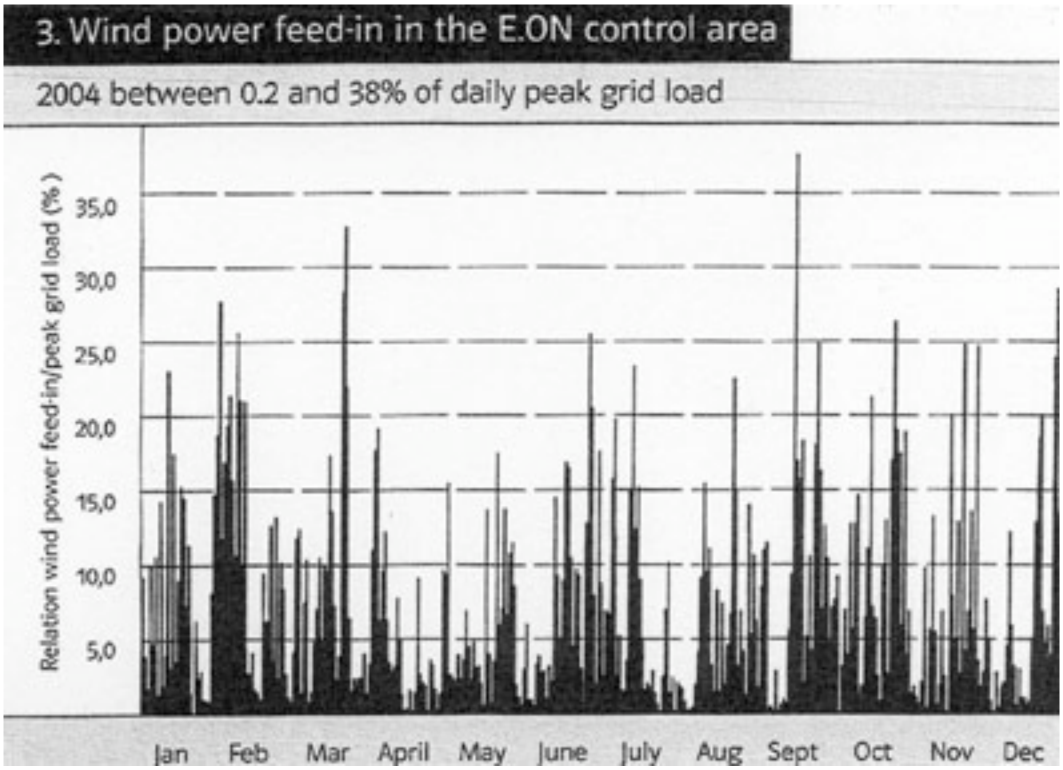


The figure demonstrates variations in the power of a single 600 kW wind turbine situated very close to the North Sea coast in the Netherlands, as measured over a full year (8760 hours).

Figure 2 (below), taken from the German Eon Netz (E.ON) *Wind Report 2005*, depicts the hundreds of marked but completely unpredictable variations during a year of generated power determined by the previously mentioned formula.

The figure shows the total hourly output in 2004 of 7000 wind turbines spread over several thousand square kilometres, from the North Sea and the Baltic Sea to the Austrian-Swiss border. Variations between 0.2 and 38 % of the E.ON grid's daily peak load occur. This is certainly not a reliable supply of consumer electricity, and in fact implies severe risks for a stable electricity net. It also proves that distributing wind turbines over a wide area does not help to prevent extreme and random variations in the total wind power.

Figure 2 *(figure 3 in the E.ON report)*



The figure demonstrates the striking similarity to the variations depicted for a single turbine as shown in Figure 1. It is easy to see that attempts to diversify the wind turbines over a wide area fail to make the aggregate power steadier. The sum of randomly occurring phenomena can never result in a steady phenomenon. More will be explained in the chapter about the differences in behaviour between other sorts of prime movers and wind turbines.

Efficient use of wind turbines is possible

Nobody can deny that a wind turbine makes use of the free available driving power of wind. And as a Dutchman I am certainly not against the intelligent use of wind energy; after all, 30% of our country was 'created' using wind power.

Indeed a number of possibilities exist to employ wind turbines as the driving power for many useful machines without incurring serious disadvantages and risks while generating electricity for the national grid. This book is concerned only with the disadvantages and risks that arise from the *erroneous* use of wind turbines. An intelligent and efficient use - during which there would be no disadvantage if the wind strength varied - include:

- Pumping water out of ‘polders’ (low-lying areas of land that have been reclaimed from water and are protected by dikes), which is how a large part of Holland was created;
- Driving mills for cereals and other products;
- Driving water pumps for the irrigation of agricultural areas;

Charging small batteries at isolated locations for limited local use. For instance, this made it possible to listen to the BBC news during WWII Who does still remember the BBC call sign • • • □ • • • □ ?.

For these applications no heavy and reliable electricity generation would be necessary and no serious risks would be involved if the turbine failed to produce constant and reliable power.

Thus, the purpose of this treatise is certainly not to slate all wind turbine applications, but to expose the fallacy that wind turbines are a blanket solution to the planet’s energy problems.

Numbers and technical units, conversions and consumption

It is important to understand that ‘power’ and ‘energy’ are two wholly different concepts.
Power is measured in watts or kilowatts;
Energy is measured mainly in kilowatt-hours.
This is because

Energy = Power x Time.

Ranging from smallest to largest, the units for electric power are:

Watt	(= 1 Watt)
Kilowatt	(= 1,000 Watts)
Megawatt	(= 1,000,000 Watts)
Gigawatt	(= 1,000 Megawatts or 10^9 Watt)

Kilowatt is often written kW
Megawatt is written MW
Gigawatt is written GW

Because energy = power x time, every energy designation is a combination of a unit of power and a unit of time (mostly hour or year). Examples are kilowatt-hour (or kWh), megawatt-hour (or MWh) and gigawatt-hour (or GWh). In addition, we have kilowatt-years (kWyears) and megawatt-years (MWyears).

The unit Joule is used at times to indicate an extremely small measure of energy. A Joule is the equivalent of 1watt-second. Thus, the larger amounts of energy expressed in Joules have the prefix Tera ($= 10^{12}$) or Peta ($= 10^{15}$). You will cccasionally see the term PJ, meaning Petajoules. In this case it is good to know that:
1 PJ = 31.7 MWyear
1 PJ = 2.78, 10^{5} MWh
As the production of energy (the kWh) by a wind turbine is essential, the term 'wind energy' - instead of 'wind power' - is used in the title and throughout most of the text in this book.

Advantage of converting kWh into kWyears, MWyears or GWyears
To obtain a more realistic and transparent figure, the number of hours in a year, **8760**, should be used when converting the huge numbers relating to a country's electricity consumption. At the moment, national consumption is generally expressed in such an enormous number of kWh that it is difficult to determine what that number really means. When these kWh are converted into kilowatt-years (kWy) by dividing by 8760 the resulting information is considerably clearer.

For example, the annual national electric power consumption of the Netherlands in 2005 was approximately 113,880 GWh. This huge number provides little understandable information. By converting these GWhs into GWyears by dividing 113,880 by 8760, one arrives at 13 GWyears, or 13,000 MWyears. By simply omitting the suffix 'year', one sees immediately that the total consumption of electricity in the Netherlands was generated by an average aggregate power of 13,000 MW from all the contributing power stations.

According to official information, the total electricity consumption in the UK in 2004 was about 402,960 GWh, or 402,960,000 MWh. Again, dividing by 8760 we arrive at 46,000 MWyears, showing that all the electricity in the UK was generated with an average total power of 46,000 MW. (This is some three-and-a-half times the power generated by all the power stations in the Netherlands plus the approximately 20-25% that was imported, mainly from nuclear power stations in Belgium and France).

As one will notice later, this conversion into kWyears or MWyears also demonstrates unequivocally that most reports about the usefulness of wind turbines are misleading, because the negative properties of the machines are concealed. Only if one examines the amount of a country's total consumption of electric power in kWyears and then compares this to the amount of kWyear production by wind turbines will the unreliable nature of wind power become evident. This is even more disturbing when one realises that the total energy consumption of an industrialised country is almost ***six*** times greater than the mere electricity consumption.

It is important to remember that what is called the 'efficiency' of a machine, say a steam turbine, is a notion quite different from its 'production factor' (or 'capacity factor').

Also significant is that data about the total national electricity consumption in some countries is not always based upon the same statistical system. In this book I have used the following numbers to indicate approximat*e* MWyears:

Table 1: Electricity consumption of certain countries

UK	46,000	MWyears	(2004)
Germany	60,300	MWyears	(2005)
France	49,435	MWyears	(2003)
Spain	26,380	MWyears	(2003)
Netherlands	12,500	MWyears	(2004)
USA	417,000	MWyears	(2003)
China	247,717	MWyears	(2004)
India	59,246	MWyears	(2003)
Canada	59,463	MWyears	(2003)
Brazil	42,373	MWyears	(2003)
World	1,630,000	MWyears	(2003)

Technical properties of prime movers: steam-, gas-, water- and wind turbines

Steam turbines

These machines are propelled by the exceedingly strong driving force of many tons of steam at extremely high pressure and with a high temperature at the inlet. The steam flows at a significant speed through the machine until it has transmitted all its energy to the rotor, ending at vacuum pressure in the turbine's condenser. In this way almost nothing of the incoming steam's initial driving force is lost. The turbine rotor contains many rows of blades, against which the force of the steam is transmitted. With its hundreds of blades, the rotor resembles an enormous porcupine.

The huge turbines in power stations use three stages of steam: in the machine's high pressure turbine, in the medium pressure turbine and in the low pressure turbine. The turbine's total output force can be regulated between maximum power and a lesser power by varying the inflow of the steam, as required. Changing the power output of a steam turbine can take considerable time. This is a highly important property for the functioning of the turbine, in parallel with the large but uncontrollable varying power input from wind energy.

For a relatively large and modern steam turbine, the properties of the steam at the inlet can be: pressure up to 185 atm and a temperature of 550 degrees Celsius. This means that the driving energy of the steam is immense.

A steam turbine can maintain its maximum power of hundreds of MW for many months without interruption. A modern machine like this runs with a thermal efficiency of 46-48%. The capacity of most power station turbines ranges from about 100 MW up to 600 or even 800 MW. These levels can be maintained for weeks or even months at a time. Before commissioning a new turbine it is normal practice to demonstrate empirically that production at a steady full capacity can be maintained without interruption for a whole week or even ten days. It is during this 'guarantee test' that the predicted thermal efficiency is measured.

Gas turbines

In a combustion chamber, a significant amount of hot gas is produced by burning either liquid fuel or natural gas. In principle, the rotor of a gas turbine resembles that of a steam turbine. Gas turbines can have a maximum power of many MW, and they can also be regulated between maximum and minimum power. The hot gas has an immense driving force as well. A gas turbine can maintain its power uninterrupted for a long period, and in power stations often up to 600 or even 800 MW.

Water turbines

These machines are driven by the high kinetic energy of a massive amount of water (1000 kilograms per m^3) flowing at high speed through the machine. For large water turbines the mass of the driving water is many tons per minute, and a power of many up to hundreds of MW can easily be reached. Total power output can also be precisely regulated by varying the amount of incoming water.

Wind turbines

The purpose of this book is to equip the reader with as much solid information as possible about the facts and the fiction surrounding wind turbines. Thus, it will be necessary to examine closely a number of aspects.

The production of electric power by wind energy

Chart of speed and kinetic energy of wind

Firstly, let us remember that wind is a form of solar energy, and is caused by the uneven heating of the sun's atmosphere, by irregularities on the earth's surface and by the earth's rotation.

The terms 'wind energy' or 'wind power' describe the process by which the wind is used to generate mechanical power and from that electricity.

Secondly, the production of electric power by wind energy is achieved in the following successive steps:
A. It begins with the kinetic energy of the wind as the primary power source, which is highly variable between zero and maximum and is only unpredictably available. This was explained in the first chapter of this paper

B. This kinetic energy is then transformed into a mechanical force by the rotor blades of the turbine, with a certain 'propeller efficiency'. This

propeller efficiency is not very high, also because a part of the original driving power is lost. This is because a considerable part of the wind blows undisturbed through the propeller circle between the two or three rotor blades. There is, according to a 'law of Betz', even a maximum of the efficiency of the propeller.
Unlike the functioning of a steam- gas- or water turbine there is no difference of the air pressure between the front and the backside of the impeller.
The remaining power is what drives the electrical generator. (The unavoidable random variations of the power output are shown in the figures 1 and 2 of the first chapter)

C. The generated current is then transformed by a semiconductor circuit into a current of 50 or 60 cycles.

D. This current is then given the voltage appropriate to connect to the utility grid by a transformer.

Those figures 1 and 2 show that the output of the wind turbine or wind turbines fluctuates over a year randomly with hundreds of variations between zero power and maximum power. Because of its negative implications, however, that fact is generally concealed by promoters in their contrived descriptions of the advantages of wind energy. In any report about wind energy written by its advocates you will notice at once what is *not* told.

Therefore, it is important to understand that the entire process from wind to electric power as it is fed into the grid is governed totally by a random behaviour of the wind's kinetic energy. This is a random behaviour that can not be restrained. Not by whatever measure. And not by whatever the promoters of wind energy assert. It is just the result of a Law of Nature.
How would an output that varies with the third power of the speed of the driving medium ever result in a reliable, a useful producer of electricity? A change in wind speed from the speed for producing maximum power to half of that speed will reduce the output to 1/2 x 1/2 x 1/2 = 1 /8 or 12,5 %... This illustrates the need to keep that third power in mind, because that cube really determines *all* the aspects of wind energy, whether technical or economical. Everything.

One really has to be a great optimist to think, or assert, that such a strange machine can be used for giving a security of supply of electricity. And a

security of supply is of course the first requisite for operating an electricity network
It is clear that this uncontrollable behaviour of a wind turbine is also incomparable with the functioning of steam-, gas- or water turbines'

Further on in this paper the very important disadvantages and their 'collateral' risks for a national electricity grid are explained.

Understanding the Beaufort wind scale.

The severe dependence of the kinetic driving energy of the wind turbine on the wind speed is demonstrated in the following chart (Table 2), in which it is postulated that the kinetic energy needed for 100% power is reached at a wind speed of about 55-60 km/h (Beaufort 7). Above 60 km/h, the propellers are often pitched in such a way as to prevent the generator overloading. This chart shows that a wind turbine is only able to generate electricity in the narrow margin between Beaufort 4 and Beaufort 8. Below Beaufort 4, so little electricity is produced that the wind turbine is shut off from the grid. Above Beaufort 8, the machine is turned off to prevent the generator overloading or to forestall serious damage to the rotor blades, including the possibility of pieces of them being hurled away.
(See http://www.caithnesswindfarms.co.uk/Downloads/Accidents%20_Jan2006.pdf for authenticated reports of accidents and deaths involving turbines and propeller blades.)

Promoters and manufacturers of wind turbines often boast that their machines are able to produce electric power at Beaufort 3; some even state that the turbine 'begins to rotate' at Beaufort 2. These claims are highly improbable. What is never mentioned is that the produced kW are then either zero or are immeasurably minimal.

Table 2: Wind speed according to the Beaufort wind scale, in metres/sec and km/h (Maximum power of wind turbine at about 55 km/h-60 km/h.)

Wind force according to the Beaufort Scale	Wind speed in m/sec	Wind speed in km/h	Kinetic energy (at the km/h speed in brackets)
2- Light breeze	1.6 - 3.3	5.8 - 12	(10) zero
3- Gentle breeze	3.4 -5.4	12 - 19.5	(18) nearly zero
4- Moderate breeze	**5.5 - 7.9**	**19.5 - 29**	**(25) 4%**
5- Fresh breeze	**8.0 - 10.7**	**29 - 38.5**	**(35) 20%**
6- Strong breeze	**10.8 - 13.8**	**38.9 - 50**	**(45) 43%**
7- Near gale	**13.9 -17.1**	**50 - 61.6**	**(60) 100%**
8- Gale	62 - 74	62 - 74	**(70) 160%**
9- Severe gale	20.8 - 24.2	75 - 87.4	Out of service
10- Storm	24.5 - 28.4	88 - 102	Out of service

A graphic of the produced power in kW would show a very steep falling ***concave* (= *hollow*)** curve from maximum at about 60 km/h to zero. Modern wind turbines use pitching of the propeller blades above this 60 km/h to prevent the generator overloading. A graphic of such turbines would show a ***convex*** *leveling* of the produced power from 60-80 km/h.

Wind turbines are taken out of service at a wind speed *under* Beaufort 4, when they produce almost nothing, and are shut down at a wind speed *over* Beaufort 7 to 8, because of the risk of damage to the propeller. Thus, wind turbines are normally only in operation between Beaufort 4 and Beaufort 8, as is indicated in boldface in the above scale.

During what we might call 'nice, quiet weather', wind turbines produce no electrical power at all. Remember too that wind seldom blows at the very high Beaufort 7 level, so maximum power is rarely attained.
For the truth, simply listen to or look at the weather report.

It is clear from the numbers above that the generating power of wind turbines fluctuates strongly with the speed of the wind. Hence, it is misleading to assert that every year wind turbines in a certain region will produce about the same average number of kWh during a particular period or season. In fact, it is untrue because the produced kW and kWh vary from day to day, even from hour to hour. The outright lie concerning a predictable

wind speed during certain periods in successive years is often told and is even depicted in skewed statistics in official reports to disguise the uncontrollable and unpredictable behavior of wind speed and wind turbines. There is simply no place on earth where the wind blows at exactly the same speed, year in, year out. And as we have seen, only a slight variation in wind speed changes the generator output sharply and uncontrollably.
Blame it on the unavoidable $\mathbf{v}^3$ factor.

Aggregate wind power of 7000 wind turbines

The aforementioned German E.ON *Wind Report 2005* shows in the graph (Figure 2 in this paper) variations in the *total power* of no fewer than 7000 wind turbines spread over some thousands of square kilometres from the North Sea and the Baltic Sea to the Swiss-Austrian border. This graph for any other year would show the same kinds of variations, but of course not for precisely the same moments or days as shown here for 2004.

It is clear that because of this wind turbine behavior it is unrealistic to demand a guarantee test, such as for a steam turbine. The predicted performance of a wind turbine will always be guesswork.

Diversifying the wind system: Scotland and Cornwall

The above-mentioned graph (Figure 2) indicates it is blatantly untrue that by spreading wind turbines over a wide area it would be possible to generate a near-steady aggregate power from the combined turbines. Some wind energy promoters refer to this as ‘diversifying the wind system’.

Picture the following scenario:
An enormous wind farm is constructed in Scotland. The aggregate power of these turbines, costing millions and millions of pounds sterling, shows unfortunately almost exactly the same random variations as the 7000 widely dispersed wind turbines in the E.ON region in Germany (see Figure 2). An ingenious solution to this problem is then recommended: a similar wind farm should be built in Cornwall for approximately the same amount of money. Wind energy scientists predict in an official British report that - almost synchronous with the Scottish dips from maximum to zero - Cornwall will produce as much power as is necessary to fill these power gaps in Scotland.

At the moment the wind speed slackens to B4 or even lower in Scotland, the wind speed in Cornwall will rise to a gale level of B7 or B8. And vice versa. What a marvelous solution. These scientific experts advise initiating two enormous and horrendously expensive projects to assure that (fingers crossed) approximately the same total steady capacity of one of these projects will be produced. To synchronize two randomly occurring phenomena is quite a feat. These scientists clearly have an enviable relationship with the UK weather gods. Because according to mathematics and also according to simple common sense: the sum of two random occurring phenomena will always remain random

Let us hope, of course, that the ingenious creators of the Scotland/Cornwall 'diversified wind system' will not forget to build in parallel three or four 380 kV power lines to transport that formidable power from south to north or north to south. Naturally, this will involve many large switching and transformer yards between Scotland and Cornwall to tap off some of the power for the regional customers and for interconnection with the national grid. Thus, we are looking at an enterprise that will cost approximately one billion pounds sterling but that will certainly never work as promised. In addition, all the extremely expensive 'extras' needed to facilitate collaboration between the wind turbines in the north and the south will themselves produce not one single kWh of electricity. Remember that.

This scenario is tantamount to a group of operators of a number of large power stations simultaneously turning the fuel supply to their turbines on and off, the whole year around. When you look at the total of the varying aggregate wind power in Germany (a staggering 7050 MW), you will see that this comparison is in no way exaggerated. In the E.ON region it would take the operators of twelve huge power stations to produce the same effect. The same thing will of course happen in Britain and elsewhere, and will result in exactly the same overwhelming predicament as exists in Germany. In their report, the German E.ON scientists - the engineers responsible for 7000 wind turbines -have stated: 'We have no solution for these problems.'

Modern wind turbines

A modern wind turbine is a machine that makes maximum use of that small driving force of the wind per square metre of the propeller circle. This means in the first place a system by which the turbine turns very quickly into the direction of the wind. Every modern turbine nowadays uses an exceptionally efficient system to achieve this.

The propeller efficiency through which the wind energy is used to drive the propellers is currently at its technical and even theoretical maximum. An improvement is scarcely possible, similar to the efficiency of the generator and the static (semi-conductor) converter that transforms the electricity from the generator into a current of 50 or 60 cycles, as needed in the power grid.

Therefore, there remains a single likelihood of raising the kWh output of the whole machine: capture as much wind as you can by making the propeller circle as large as possible. A gargantuan offshore turbine of 5 MW has now reached this capacity, with 61.5metre-long rotor blades than can move in a circle some 126 metres in diameter. At 17 rotations per minute, this equates a speed measured at the tips of the propellers at about 6.7 km/min, or 403 km/h. One can imagine that these dimensions and speed place an enormous strain on each part of the turbine, from the foundation up to the tip of the propeller at a height of 163 metres. For this reason, 5 MW is the capacity limit of modern wind turbines, as well as what can be produced annually in kWh. (These dimensions were published by the German company REpower for their 5 MW wind turbine on the North Sea off the coast of Scotland which was put into operation in July 2006)

Thus, although a modern wind turbine is undeniably an ingenious machine, as you can see by now it employs the weakest, most erratic driving medium imaginable: the wind. This means the predictions cannot be true that wind turbine efficiency will improve in the future because of a so-called learning curve. How could this be possible when the properties of the wind's driving power will never change? Hence, the speculation about a learning curve is mere wishful thinking. It is pure fiction.

A guarantee test as described for steam turbines is not possible for wind turbines. The number of kW and kWh produced in the course of a year is a matter of prediction. The sharp variations in the generated power will always be similar to those shown in Figure 2 (taken from the *Wind Report 2005*) because these are bound to that unavoidable physical law: $\boldsymbol{E = f.m_{spec}.\ v^3}$.

Implications of the production factor/capacity factor

On the mainland of Europe, 'capacity factor' is generally referred to as 'production factor' because it is a measure for the kWh produced. This factor indicates the actual kWh produced by a wind turbine, taking into account each interruption and variation during one year as a percentage of the total amount of kWh that would be produced in a year with continuous maximum power.

Production factor denotes the idea better, so I will use only this term. The expression is more a notion concerning the actual produced kWh than the involved 'capacity' of a wind turbine. In addition, as stated previously, the concept of a machine's production factor is completely different from that of a machine's efficiency. Promoters of wind energy delight in describing the efficiency of wind turbines, even though it is nonsense in terms of evaluating a wind turbine's usefulness.

In the E.ON graph (Figure 2), we can see that the total yearly amount of kWh is produced with considerable inconsistent power output of varying duration. The total amount of produced kWh expressed by that production factor in such a haphazard manner can of course be only a small percentage of what might be produced with continuous full power.

Hence, it is important to keep in mind that the total amount of kWh's generated in a year by a wind turbine is never produced with a steady flow of kW's, although promoters of wind energy often try to make the public believe that it is. On the contrary, the produced current and therefore the produced kW's vary constantly and with unpredictable variations of unpredictable duration, thus making wind energy unsuitable as a reliable and sustainable supplier of direct electrical power to consumers. The annual kWh production by wind turbines is always the sum total of hundreds of small portions of kWh's. Wind energy promoters strive to conceal this fact. They state: 'This turbine will produce with an efficiency of such and such', and then they mention a production factor. All of this is misleading fabrication.

Depending on a number of circumstances, the production factor of onshore turbines can range from a low 13% up to 25% for modern state-of-the-art and very tall turbines in a location having more or less continuously strong winds. In extremely rare situations the production factor can reach 30% in coastal areas. Because of its complete unpredictability, however, that factor will never be the same in successive years. It will always be a matter of 'let's wait and see', and this is why it is absolutely impossible to guarantee that a certain production factor will be reached.

Production factors in Europe

It is interesting to see the production factors that were measured in 2004 for the aggregate wind power in the Netherlands and Germany.

The Netherlands
In 2004, a production factor of 22% was measured - not predicted - for a total of 1600 wind turbines. This factor will certainly rise somewhat, perhaps up to 24%, due to 're-powering' several of the more than 800 80 kW-capacity wind turbines, most of which run with a production factor of 13-15%. This is the equivalent of an average power of 10.5-12 kW, or the power of an electric wheel chair.

The building of these wind turbines, however, was intensively, and using strong pressure, recommended by the Dutch government and all the organisations which had and have an interest in building wind turbines as a seemingly effective method to help prevent global warming. Methods used to convince the public were unsavoury and highly questionable.

Germany
As can be calculated from the measured - not asserted - numbers in the excellent E.ON Wind Report 2005, the average production factor in 2004 for the more than 7000 E.ON wind turbines, distributed over thousands of square kilometres, was 18.3%. Due to the construction of several new turbines, this production factor had risen to around 19% by the end of 2004. In the month of July, 2006, the production factor for all the wind turbines in Germany was measured at 7.5%.

These numbers demonstrate that one should exercise extreme caution in the face of claims that the average long-term production factor for onshore wind energy turbines in the UK can be estimated at 27% or sometimes even at 35%.

A production factor can ***never*** be predicted; not for hours, days or months, and even less so for consecutive years. It would be irresponsible to design a system for national electricity production that is based only upon an assertion that the wind speed ***on average*** will behave as one hopes. Such a system can and must only be designed based on a near 100% certainty that every technical component will function as it should.

Clearly the reliability of a national electricity supply cannot be determined by flinging coloured beads and chicken bones to the floor and appealing to the weather gods. Yet promoters of wind energy often give this impression when they argue: ‘Really, on average over a month or a year the wind blows much more regularly than from minute to minute or from hour to hour.’ But they are guilty of overt deception by even concocting a graph that shows only an averaging of the wind speed over a certain period.

Variations in unpredictably produced kilowatts

In this section you will encounter information given previously in this treatise. However, the facts are simply too important not to be repeated.

In many effusive stories about wind energy you will certainly come across the assertion that wind turbines will produce electricity with a steady power of a certain number of kW, conforming to the production factor. By referring to a 3 MW turbine and a production factor of 25% , promoters try to convince you that the turbine will produce electricity with a steady power of 0.25 x 3000 = 750 kW. This is once again misleading, because what the turbine produces during a year is the <u>total sum of hundreds of small and varying quantities of kWh. They alter because the power varies during hundreds of periods of changing length.</u> A wind turbine will never and can never produce electricity at steady power.
It is necessary to call attention to this fact repeatedly, because propagandists of wind energy ceaselessly try to conceal this fact.. Sometimes they do this by publishing a graph that depicts the average power over a certain period, or over days or a week or even a month. This is intended deception. They want you to forget the essential difference between produced kilowatts (i.e. power) and produced kilowatt-hours (i.e. energy).

Why wind energy is entirely unreliable

Everything in this book is based upon that fact that wind energy can only produce electricity unreliably and in minimal quantities. This will, of course, be vehemently denied by anyone with a personal or political interest in the construction of wind turbines. Perhaps even they could be convinced by the following mutually corroborative evidence:

1. The fixed formula $\boldsymbol{E = f.\, m_{spec}.v^3}$ already indicates <u>all</u> the important facts: electricity produced by wind turbines is minimal and completely unpredictable and therefore unreliable;
2. This is confirmed by the graph in Figure 2, which depicts the unreliability of the aggregate production of 7000 widely dispersed turbines. Electricity produced by wind turbines is a random phenomenon;
3. Every discussion about how much the production factor will be (from below 18% to a highly improbable 35%) is in itself already full confirmation of the unreliability. It proves that the kWh or kWyears must have been produced with an extremely varying power. Were it not so, this number would of course be in the region of 90% -95%, as can easily be reached by normal, i.e. conventional steam-, gas- or water turbines.

The small nuclear power plant Borssele (450 MW) in the Netherlands runs with a 'capacity' - or production factor - of 94%. This translates to steady full power for almost the whole year.

(Worth repeating is that the *production factor* of a wind-, steam- or gas turbine or any other machine is quite different from the *efficiency* of that machine.)

It seems strange that promoters of wind energy - whether official, political or so-called specialists - never mention the significant disadvantage of wind energy: namely, its complete unreliability. One might justifiably suspect that a hidden personal or political agenda is at play here.

How can high production factors for other prime movers be reached? Quite simply because it is up to the operators of these power plants to decide how much power is needed at a particular time. These prime movers are not dependent on the strength of the wind or on the state of the weather.

It would be foolhardy to build any kind of power plant, whether steam driven, water powered or nuclear powered, for which it would be necessary to check the daily weather forecast. Ridiculous to imagine that if by chance the wind did not blow at exactly the right strength, the operator would be forced to phone a colleague at a conventional power plant, with the urgent request, 'Hey, George, I'm short of quite a few megawatts today. Can you help me out?'

Why wind energy will remain expensive

Wind energy is and will remain expensive because of the combined properties of wind turbines.

Let us assume wind turbines are built at a cost of several million pounds sterling. (Indeed, they cost roughly 0.8-0.9 million pounds sterling or 1 to 1.3 million euro per MW capacity onshore.) The price is of course related to the capacity, to the maximum power of the machine, and is the price for 100% power. Over a given year, however, the turbine will produce on average only 25-30% of its power capacity. This means that of the price for 100% power, about 70-75% is flung to the winds, so to speak. The 70-75% on average does not produce a single kWh. On top of that, the dismal amount of the product, the kWhs, is of very poor ‘quality’: namely, only available with hundreds of variations between zero and maximum, and on many days not available at all. This is the worst property for an electricity supply to have, making it unviable for supply to single consumers, a factory, a hospital or a household. Such a dismal product is of course of reduced value on the energy market and can only be sold at a reduced price, making massive subsidies necessary. These subsidies are paid by the general public.

Moreover, on the conventional energy market it is possible to write a contract for a supply of X number of megawatthours of electricity during a certain period: it can be next week or even next month. This cannot be done for MWh’s produced by wind turbines. Thus, MWh’s produced in a traditional manner are much more valuable than the unpredictable MWh’s produced by wind turbines.

One can make the following simple comparison:
A car that can be used every day with unfailing reliability will certainly be more valuable than a car that you can use only after determining whether the weather is auspicious. Again, this means that wind turbines can only be operated economically with substantial subsidies and with the taxpayer being hit with a higher electricity bill. Anyone can understand this. It is simply inevitable that the taxpayer will pay a great deal of money for an unreliable product that is the source of highly dangerous consequences for the country’s safe and reliable electricity supply.

Now let us turn from the financial aspect of wind energy and examine some of the technical difficulties and related risks. We saw that the electric power produced by wind has severely inconsistent variations between zero and maximum power. Unpredictable variations of likewise capricious durations lasting from minutes to days are shown in Figure 2 for the aggregate power of 7000 wind turbines distributed over an area of many thousands of square kilometres in Germany. (In the highly misleading report *Windpower and the UK wind resource,* published by the University of Oxford Environmental Change Institute, this is called 'diversifying the wind system').

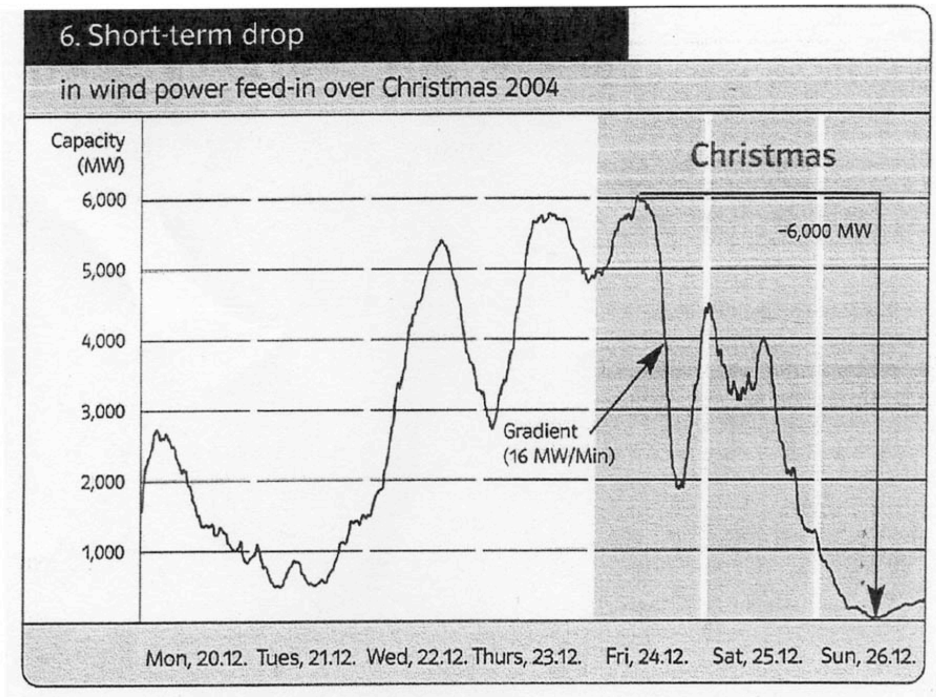
From the graph (Fig 2) it must be clear that variations of such magnitude in the input of wind energy into the normal electric grid will result in extremely unstable situations for the maintenance of a reliable supply of electricity to consumers.

As electricity is neither compressible nor elastic, each kW that is consumed (or not consumed) must immediately be followed by adaptation of the input from the power stations into the grid. When a considerable input of wind energy varies more quickly than can be followed by the adaptation of the power stations, the whole system will break down. The result will be a complete national or even an international blackout

Adaptation of the aggregate power of many hundreds of interconnected traditional power plants to the demand takes time and is certainly not as variable as changes in the wind speed.

These unpredictable and rapid variations in the input from wind energy, from very high to suddenly very low, can lead to severe regional blackouts not only in Germany but in many parts of central Europe. The E.ON Wind Report 2005 states that the feed-in capacity of their 7000 wind turbines change often and dramatically, and they give an example: 'On Christmas Eve 2004 wind production in Germany fell 4000 MW in 10 hours, representing the capacity of eight 500 WW coal-fired power plants! This created an enormous challenge for the operators of the grid and it could easily lead to a vast blackout in Europe.' An incredible amount of luck would play a role as well.

Figure 3, taken from that report, depicts what happened.



It is inevitable that catastrophes will happen in the near future. In the candid German E.ON *Wind Report 2005*, E.ON scientists and engineers state: 'We see no solution for all the difficulties that can arise.'

A special warning for the UK

The risks for severe disturbances of the national electricity supply caused by the extensive use of wind energy are even more real for the UK than for Germany. The latter is interconnected to the electricity grids of the neighbouring countries by very strong ultra-high voltage lines that can function as a safety net when sudden variations in the total wind power output occur.

The UK has no such strong connections to surrounding countries. That is why the risks for the UK will be incomparably greater than they already are for Germany.

Wind energy: Always a poor substitute for traditional power stations

Because of the unreliable and varying production of electricity by wind power, the guaranteed wind power capacity is never more than 10% of the total installed wind capacity. For the safe operation of a national grid, it would be dangerous to reckon with more than this amount as a substitute for traditional power stations. With a very intensive use of wind power, this percentage even falls below 8% to about 4%, as is explained in the *E.ON Wind Report 2005*. (The more wind turbines are interconnected the greater the difference between full aggregate power and minimal power will be. That means that interconnecting a large number of wind turbines will not improve the reliability of the aggregate production of electricity but diminish the ‘security of supply’)

In the event of a rapidly changing wind energy input, the reachable adaptation rate of the traditional power stations’ total power determines at what percentage the installed wind power can be considered a safe substitute. That percentage also depends on the possibility of quickly producing more power to fill the gap caused by the diminished wind power. This means that traditional power stations will remain essential simply because of considerable wind power. Approximately 90% of the installed wind power is needed as a reserve capacity.

Moreover, the balancing act between the production possibility of traditional power stations and the unforeseeable variations of wind energy makes the safe operation of such a grid extremely difficult, if not impossible.
To better comprehend the complexity of the problem, the reader is advised to examine again Figure 2, which depicts variations in the aggregate wind power of 7000 wind turbines.

It will be self-evident that in a country with so much unreliable wind power, spread over a wide area, it would be necessary to build a large number of new ultra-high voltage, 380 kV lines (with of course the necessary switching and transformer stations) to transport that highly variable electricity supply to where it is needed. In Germany, the cost of these provisions, made necessary only because of wind energy variables, is estimated at about 3 billion (yes, *billion*) euros. Two billion Pounds Sterling..

Remember, all these problems originate from the formula $E = f.\ m_{spec}.\ v^3$.

'Households' is not a unit of measurement

Most information about the benefits of wind farms or wind farms states that the wind turbines involved will produce sufficient electricity to supply X number of 'households'. An impressive number then follows. This ploy is used to induce people to believe the wind turbines are exceptionally useful for the production of a great deal of renewable or sustainable energy. The implication is also that these wind turbines will supply all the electricity for everyone in the village or in a specific region. This is simply not true. Let us look at the reality:

1. Because of the entirely unpredictable and varying amount of electricity produced by wind energy, no consumer can ever depend upon a reliable supply. In fact it is naive to believe that wind turbines really produce electricity for households. At least 99.5% of the current in a wall plug is quite commonly generated by means of a traditional power plant. Often it will be 100%.
2. No one will ever be able to adequately measure the number of households, and it would also be foolish to forget that almost every community has numerous other users of electricity: namely, shops, municipal sewage pumps, hospitals, schools and so forth. The bottom line is that a wind farm's usefulness can never be reflected in that imaginary measurement designated as 'households'.
3. The term 'households' does not exist as a unit of measurement. The only correct and controllable measurement relating to the production of electricity is the number of kWh's (kilowatt-hours) or kWy's (kilowatt-years). Only because it is impossible to guarantee or predict the kWh production do builders and advocates of wind turbines use the fantasy measurement households. Once again, it is highly misleading information that intentionally hides the facts and makes the situation look far better than it is.

If you are seriously interested in the amount of electricity produced by a wind turbine, you need to ask about the amount of kWy's. By omitting the suffix 'years' you will know immediately with what average power over a year the involved wind turbines are generating electricity. Never be fooled by the expression ‘number of households’.

The minute production of electricity in numbers

To judge the production of electricity by using wind energy, it will be elucidating to make a comparison to the total electricity consumption of an industrialised country. In 2004, the total consumption in the UK was about 403,000 GWh, or 46,000 MWy. This means that in 2004 the total UK consumption was produced with an average aggregate power of 46,000 MW from all the power stations.

Let us estimate the yearly rise in total consumption to be about 2%. This indicates a yearly increase of 920 MW in the power needed from all the contributing power stations. This would equal the capacity of two medium-size power stations.
(It is clear that a country that does not continually build enough new power plants to meet consumer demands will eventually face unavoidable problems.)

We will look now at how wind turbines could participate.
Let us consider two types: the very large 3 MW turbines and the gargantuan 5 MW turbines. The massive propellers of both types extend much further than 100 metres and are clearly visible in the English countryside from many kilometres away. In Europe only a handful of 5 MW turbines are currently in operation.

We estimate that both types will run with an average production factor of 25%. This is a high number when one realises that in the Netherlands an average production factor of 22% for 1600 onshore wind turbines and in Germany an average of 19% for 7000 wind turbines was measured.

A 3 MW wind turbine
This will produce electricity with an average yearly power of 0.25 x 3000 kW = 750 kW, which is about the top power of a medium-size Diesel truck. In comparison to what the UK needs in total power production, 46,000 MW,

we see that a 3 MW wind turbine produces annually 0.75 MWy. This means 16 millionth parts (written in decimals as 0.000,016).

A 5 MW wind turbine
This monster will produce with a yearly average of 0.25 x 5000 = 1250 kW, which is the top power of a large Diesel truck. Yearly production will be 1.25 MWy. In comparison to the UK total (electric) power production needs, it is 27 millionth parts (written in decimals as 0.000,027).

It can be expected that promoters of wind energy will protest vehemently against the 25% production factor mentioned here. But even without resorting to a pocket calculator, the reader can see that also with a slightly higher production factor we would gain only a few more millionth parts. And do not forget that 25% was reckoned as an *average* number and that it is impossible to predict and guarantee a certain production factor (or capacity factor). A production factor can only be measured after 12 months of operation and it will vary from year to year. A prediction that wind turbines in some regions will have a strong production factor can only be a guess, and it will also vary from turbine to turbine.

Still more revealing is the dismal production of electrical energy by wind turbines when compared to the total energy consumption in the UK. As already stated, in most industrialised countries the total yearly energy consumption is about ***six*** times greater than that of only electricity. This brings us to the following conclusions:
A 3 MW wind turbine produces about a 2.7 millionth part of the UK's total energy consumption (written in decimals as 0.000,002.7);
A 5 MW wind turbine produces about a 4.5 millionth part of the UK's total energy consumption (written in decimals as 0.000,004.5). How miniscule the production of electricity by a 3 MW wind turbine is in comparison to the electricity and energy consumption of a number of countries is shown in the following table.

Table 3: Energy production from a 3 MW wind turbine in comparison to total electricity and total energy consumption in certain countries

Country	Total electricity consumption in MWyears	Output with respect to national electricity consumption	Output with respect to national energy consumption
UK	46,000	$16{,}10^{-6}$	$2.7{,}10^{-6}$
Germany	60,300	$12.4{,}10^{-6}$	$2.1{,}10^{-6}$
France	49,463	$15.2{,}10^{-6}$	$2.5{,}10^{-6}$
Spain	26,380	$28.4{,}10^{-6}$	$4.7{,}10^{-6}$
Netherlands	12,500	$60{,}10^{-6}$	$10{,}10^{-6}$
USA	417,000	$1.8{,}10^{-6}$	$0.3{,}10^{-6}$
China	247,717	$3.0{,}10^{-6}$	$0.5{,}10^{-6}$
India	59,246	$12.6{,}10^{-6}$	$2.1{,}10^{-6}$
Canada	59,463	$12.6{,}10^{-6}$	$2.1{,}10^{-6}$
Brazil	42,373	$18{,}10^{-6}$	$3{,}10^{-6}$

The numbers in Table 3 are based upon an average production factor of 25% and upon the presumption that the total energy consumption of a modern country is almost six times more than the electricity consumption. (In reality this number is even 12 for the USA !)

One must remember that the yearly output of a wind turbine is not produced by a steady power (kW), but that the output is produced as the total sum of hundreds of small portions of kWh produced by kW that vary unpredictably between zero and maximum and that are of varying unpredictable duration.

These numbers demonstrate unequivocally that it would be impossible to save the world from the most devastating global warming-related disasters through the use of unreliably functioning wind turbines. They also show that it is not difficult to guess the real motives of people who insist that wind energy is the ultimate solution to our energy and climate problems.

It must be evident that the real problem is to find methods to produce enough energy in a reliable continuous manner, and not only electricity. One might speculate that the advocates of wind energy never mention this self-evident truth because that would make their real motives abundantly clear: they are blindly following a politically dictated policy or even pursuing business or a well-paid job. How else could it be explained why some proponents and even well-known institutions publish propaganda full of blatant nonsense including statistics and graphs that are false and meant to mislead an inattentive and trusting public.

‘The biggest wind farm in Europe’ Really?

According to an article in the newspapers of October 18, 2006, the German company Siemens announced that they had received an order to build ‘the biggest wind farm in Europe’. The following information was given:
This wind farm will be built in Scotland near to Glasgow for Scottish Power: 140 wind turbines will have an aggregate capacity of 322 MW and produce enough electricity for 200,000 households. Total costs: 350 million euro (or 235 million pounds Sterling)
Let us see what more information can be derived from this newspaper announcement:
Each wind turbine will be built to have a capacity of 322/140 = 2.3 MW. A modest capacity, because the really big ones have a capacity of about 5 MW With a production factor of 25 percent this ‘biggest wind farm in Europe’ will effectively produce with an average power of about 80 MW. That is equal to the capacity of a very small conventional power station and equals not more than **0.001.7** of the total power generated by all the power stations in the UK (1.7 promille).
This makes it a joke to boast about ‘the biggest wind farm in Europe’.

As the reader will remember, the aggregate power of the wind farm will vary hundreds of time during a year between full capacity of 322 MW and near zero (See Figures 1 and 2). That means that Scottish Power has to keep about 290 MW of the conventional power stations available for speedy backup when the full capacity of 322 MW drops sharply with subsiding wind speed in order to prevent a serious blackout that could spread over a large part of England. A consequence of this is that one or two conventional power stations must be kept running at reduced power, and therefore with reduced efficiency. This means that more CO_2 will be exhausted per produced kWh.
The amount of 350 million euro (235 million Pound Sterling) tells us that the price of the UHV switch yard and power lines for transporting the power that will fluctuate between zero and 322 MW are not included in the price that was indicated in this newspaper article. This makes it clear that for an average power of a mere 80 MW this ‘biggest wind farm in Europe’ is an extreme costly affair and is producing electricity for a fancy price per kWh.

The whole project seems politically motivated, because it brings no or hardly any reduction in carbon emissions and contributes only in a minimal, even hardly measurable way to the UK's electricity demand.
It is interesting to compare the haphazard 80 MW of this 'biggest wind farm in Europe' with the security of supply by those new 1600 MW nuclear EPWR power stations that are now being built in Finland and France. (EPWR means European Pressurized Water Reactor)

Official and unofficial dogma: 'Never tell the full truth about wind energy.'

It must be abundantly clear to readers by now that the fiction perpetrated about the salutary properties of wind energy completely contradicts all the facts and proven numbers.

By understanding the consequences of that constant formula $E = f.m_{spec}.v^3$, and with just a little technical common sense, one can see already that wind energy will possess all of the unfavourable properties about which you have just read. It is therefore reprehensible that nearly all proponents of wind energy continue to disseminate the most outrageous untruths. They do this by hiding or withholding important information, by quoting wrong numbers or by publishing totally incorrect graphs or statistics.

It is easy to understand who does this and why they do it: invariably they are people with political or personal self-interest in the continuation of the wind energy fabrication.
Most people who have finally begun to realise that things are not as they first thought often do not have the temerity to admit that they were wrong. Many prefer to remain known as 'the specialist' who understands everything about wind turbines and who perseveres in writing or speaking half-truths or outright falsehoods.

‘By 2010 perhaps even 10% of the national electricity consumption can be produced using wind energy.’ Facts or Fiction?

Again let us go back to the numbers in the previous section - the minute production of electricity by wind energy - and let the numbers speak for themselves:
There we reckoned with an average production factor of 25% for onshore wind farms of 3 MW and 5 MW wind turbines. We arrived at the following numbers:
The *3 MW turbines* will have a yearly production of 16 millionth parts of the national UK electricity consumption (or 0.000,016);
In comparison to the total energy consumption of the UK, the number is 4 millionth parts (or 0.000,004).
The average producing power will be 0.75 kW. This is very little compared to the capacity of a medium-large power plant of 500 MW: 667 times more and producing reliably.

The *5 MW turbines* will have a yearly production of a 27 millionth part (or 0.000,027) of the national UK electricity consumption.
And again in comparison to the total energy consumption, the number is a 4.5 millionth part (or 0.000,004.5)
The average producing power will be 1.25 MW. The above-mentioned 500 MW power plant can produce 400 times more and with great reliability.

Further, we reckon with a yearly increase of 2% in the UK electricity demand. On the basis of these numbers, we can determine whether the intentions of a number of EU countries are grounded in reality when they state their target: ‘In 2010, 10% of the national electricity consumption will be produced by “renewable wind energy.’

In the light of media articles about this audacious intention, it was already clear at the beginning of the EWEA conference on wind energy in 2001 in Brussels (and at wind energy-related meetings on other occasions) that participants had not the faintest idea about what they had promised each other and the unsuspecting public. Were they referring to 10% of installed wind capacity or to 10% of the kWh’s or MWh’s actually produced? Apparently nobody knew precisely.

I can assert the above with some authority. Knowing I have a keen interest in the subject of wind energy, in 2005 the Dutch Audit Chamber (the Algemene Rekenkamer) sent me a copy of a report they had provided to the Dutch Ministry of Economic Affairs (and Energy). In it they told the Ministry that they would appreciate it if the reports about the international conferences in Brussels could demonstrate that participants at least understood the essential difference between installed wind *capacity* (in kW or MW) and the actual *produced* kWh's or MWh's.
It was abundantly clear that during the conferences nobody had raised a hand to ask, 'Gentlemen, what are we actually talking about? Megawatts or Megawatt hours?'
Indeed the notion 'production factor' seems to have been a mysterious one.

But to return to the official intention (which arose from the conferences in Brussels and has been published many times in the press and online): 'In 2010 we commit ourselves to producing 10% of our electricity by means of sustainable wind energy.'
Let us examine the numbers involved.
In 2004, the total consumption of electricity in the UK was produced by an average aggregate power of 46,000 MW from the combined power plants.
We estimate the yearly rise in UK consumption to be 2%. This means that from 2004 to the end of 2010 (six years) the power needed to produce the total consumption will have risen to 1.126 x 46,000 = 51,800 MW.
Ten percent of that power equals 5,180 MW, and would be produced either by 3 MW wind turbines with an effective producing power of 0.75 MW or by enormous 5 MW wind turbines with an effective producing power of 1.25 MW. Whatever the case, these numbers show that matters in the UK will need to be speeded up, for the following reasons:

- in the years between 2004 and 2010, 5,180 / 0.75= 6,907 of the 3 MW turbines should be built. This amounts to 1,151 per year, or 22 per week or just over three per day.
- Building 5 MW turbines would necessitate 5,180 / 1.25 = 4144 turbines in six years. That amounts to 691 turbines per year, 13 per week, or two daily, and over a six-year period.

Do not forget that 2006 started badly because in the first months only a very few or no turbines at all were built; thus, their construction really needs a strong boost to catch up with the prescribed program.

It would, of course, be logical to continue building turbines after 2010 to cope with 10% of the 2% yearly increase in electricity consumption. This means 0.1 x 0.02 x 51,800 = 103.6 MWy. For this it will be necessary to continue building 138 of these 3 MW turbines per year, or about three per week, year in and year out.

We are still not at the end of this extravagant story, however, because at the same time that wind turbines are built it will be necessary to construct many hundreds of kilometres of new high-voltage (380 kV) lines to transport the varying wind power to and fro between the interconnected wind farms and the traditional centres of electricity production and consumption. These new high-voltage lines are a precondition to maintain a reliable functioning of the national network. (In Germany the costs of these new transport lines, necessary only because of the extensive use of wind energy, are estimated at about 3 *billion* euros. (I urge you to read the E.ON *Wind Report 2005*.)

It is evident that notions about this 10% wind energy are based upon fiction. The basic realities of which no one seems to have taken the trouble to understand show the facts. One wonders how many hundreds of people are busy with such far-fetched ideas and how many thousands of pages have been written about them. All these activities, the impressive conferences, the attractive brochures and so on cost hundreds of millions of pounds sterling. Who pays in the long run for these undertakings? The tax payers.

The intentions for 2020 are even more unrealistic. The pressing global energy problem is too urgent to try to induce people to believe that solutions have already been found or will be easily found.
That is simply not true.

Onshore and offshore wind farms

Opposition to the building of onshore wind turbines is escalating because people have gradually begun to see that these largely obtrusive structures set in rural landscapes contribute almost nothing to the normal production of electricity. This is why in recent years the building of offshore wind turbines has been propagated as a means to produce more regular electricity on the basis of a steadier wind at sea. The fact remains concealed that also at sea the wind speed will vary considerably. The public is seldom informed that the construction and operation of offshore wind turbines is much more complicated and costly than the building of onshore turbines.

Therefore, let us examine both systems and make a simple common sense comparison.

Onshore wind turbines

Consider the numbers mentioned previously.
It would cost in the vicinity of 750,000 to 850,000 pounds sterling to build a 3 MW onshore wind turbine. In itself, the construction would not be particularly complicated: it involves a strong concrete fundament and an approximately 80-metre-high tower with the nacelle on top, which includes a large gearbox and generator and a transformer at the base for connection to the national electricity network. Add to this the infrastructure of a road to render the site accessible for building and maintenance. The most difficult aspect concerns the great height to which the heavy components need to be lifted. Regular maintenance or repair visits to the nacelle would also be problematic in a tower of more than 80 metres high.

Let us say we have built a 3 MW wind turbine, knowing it will produce electricity with an average power of 750 kW (the top engine power of a medium-sized Diesel truck) and will contribute a 16 millionth part (or 0.000,016) of the electricity consumption and a 2.7 millionth part (or 0.000,002.7) to the UK's total energy demand.

One might seriously question building an 80-metre-high tower on which to place turbine housing the size of a bus but capable of effectively producing no more power than a Diesel truck engine, and contributing so minimally to the energy demand that it is barely measurable. A tower with a propeller that extends to more than 100 metres and whose blades chop through the air at about 290 km per hour is, as Prince Charles might observe, 'a carbuncle on the beautiful face of the English landscape'. In addition, a wind turbine produces every second a loud '*whoosh'* each time a propeller blade slashes past the pylon. This sound is audible from a great distance.

It is clear that these inordinately expensive machines can only be built on the basis of extremely attractive subsidies for the builders and the promoters. In the long term, these subsidies will be paid by *you*, the taxpayer. The notion of lower electricity bills is a myth propagandized by corporate pirates.

Offshore wind farm: *Horns Rev* in Denmark

Offshore wind turbines produce only a small percent more electricity than those operating onshore. While it is a fact that the wind at sea blows more frequently and often more strongly than on land, anyone who sails knows that the strength of a sea wind is also susceptible to extreme variations. These range from violent storm level at Beaufort 11 to a light breeze at Beaufort 2. Thus, a graphic depicting the power of an offshore wind turbine will differ only slightly from that of an onshore wind turbine. The best proof of this is the production factor of 30-35% that is often predicted for offshore wind turbines. As is explained in the section *Why wind energy is entirely unreliable*, the production factor would be considerably higher, perhaps nearing 90%, if variations were absent or rare. I will expand later on this production factor and its further implications.

Now let us look at the much more complicated requirements for building an offshore wind farm. With all its components, from the fundament on the bottom of the seabed to everything in the nacelle at the top, plus the propellers themselves, the turbine itself must be built such that saltwater and saltwater spray cannot impair the safe and reliable functioning of these parts.

Because of the dangerous consequences of spray water, the hub of the propeller must be at a height considerably greater than is needed for an onshore turbine. Every entrance to the turbine and to the transformer must also be tightly sealed against spray water and hurricane force winds. The whole construction must be protected against corrosion, from bottom to top. For that reason, offshore wind turbines are quite different from and considerably more expensive than onshore wind turbines.

This is clearly demonstrated by the Danish offshore wind farm *Horns Rev*, which suffered almost catastrophic damage after only about 18 months of operation.

Horns Rev comprises 80 turbines of 2 MW situated in the harsh sea climate west of Denmark. All 80 turbines experienced an almost complete breakdown as a result of the penetration of saltwater spray. (The build-up of salt on the blades of offshore turbines has been shown to reduce the generated power by 20-30%; http://aweo.org/ProblemWithWind.html)

Each turbine had to be completely dismantled: the propellers were removed, along with the nacelles with their gearboxes and generators, and the transformers and so on. Everything was transported from that location at sea back to the factory for repair and for design changes. A programme aired on Dutch television on November 4, 2004, showed the Danish engineer who was responsible for the operation of *Horns Rev* flying low over the wind farm and explaining what had occurred. At that particular moment, and as shown on TV, only four turbines were turning, one turbine was 'temporarily out of service', and of the remaining 75 only the useless decapitated pylons were standing. It was a grim sight.

Horns Rev exemplifies many more of the predictable disadvantages that were certainly not explained to the Danish public when plans for this project were published. The fact is that 80 2 MW turbines means an aggregate capacity of 160 MW. From an electro-technical perspective it is a complicated and costly affair to transport the electricity produced by 80 turbines of 2 MW during a 'favourable wind' at sea to a connection on land. Moreover, as stated previously, all these additional and costly technical provisions do not produce a *single* kW or kWh. Thus, every kWh produced offshore is considerably more expensive than the kWh produced onshore by wind energy.

The news becomes steadily worse.

On the basis that these offshore turbines are visited every three months for servicing and maintenance, 320 visits a year to *Horns Rev* would be necessary. How these could and would be carried out is a mystery. How many helicopters and specialised maintenance ships with very high lifting facilities would be essential for this maintenance, to say nothing of the number of personnel?

The aggregate power of *Horns Rev* will vary between zero and 160 MW. Even for that fairly small total production of electricity, these relatively minor variations are enough to disrupt the reliable functioning of Denmark's electricity supply. To compensate, therefore, Denmark needs to reckon with an on-call supply from either Sweden or Germany. The kWh imported on an irregular basis from these countries will of course be considerably more expensive than the kWh produced in a traditional manner in Denmark itself. It is clear why Denmark has the highest electricity tariffs in Europe.

(Similar information relating to *Horns Rev* can be found in the October 2004 issue of *Modern Power Systems*.)

However, this is still not the end of the story.

An estimate of an unlikely high production factor of 35% offshore would mean an effective but variable producing power of 56 MW by *Horns Rev*. An onshore wind farm of 160 MW would, with a production factor of 25%, produce effectively and in the same irregular manner with 40 MW. Would an improvement of a *mere 16 MW* effective producing power be worth building 80 2 MW offshore wind turbines? It is highly doubtful.

The Danish offshore wind farm *Horns Rev* is clearly a classic textbook case that enables one to distinguish between what is true and what is not. In fact, a commissioned study of wind energy in Denmark was conducted by Norway in 1998 (http://www.bmpg.co.uk/probe.html), and the conclusion was that wind energy has 'serious environmental effects, insufficient production and high production costs'. Every single plan to build offshore wind farms around England should be analysed scrupulously within the context of the *Horn Rev* experiences.

The illusion of an offshore wind farm of 6000 MW capacity on the North Sea

The following event demonstrates unequivocally how the imagination of wind energy advocates can run riot:
Some eight years ago in the Netherlands a professor at a Dutch semi-governmental scientific advisory organisation published an article stating that it would easily be possible to build a gigantic offshore wind farm in the North Sea, by which Europe's total electricity demand could be covered. As it happened, although this professor was relieved of his post a short time later, nevertheless his bold suggestion captured the attention of several Dutch government officials and business people who glimpsed the opportunity to pursue the idea on a scale that they considered saleable to a gullible public. The concept was, quite literally, a windfall. Media articles, discussions, conferences and 'informative TV broadcasts' soon began to proliferate. Despite warnings from people with common sense, including many in the professional scientific and technical world (with no vested interest in building wind turbines), the Dutch Ministry of Economic Affairs

(and Energy) systematically ignored their appeals and repeatedly stated: ‘No, such a project is certainly not very complicated. Yes, it is a huge undertaking but the difficulties should not be exaggerated’. (This is a verbatim quote from a Ministry letter that I still have in my archive.)

Hence, even up to now, 2006, this illusion still prevails in the minds of certain individuals hopeful of a lucrative governmental or private sector position. They are adamant that it would be expedient to implement at least a small initial test case as a part of the project. ‘Yes, it could be extended later to the full 6,000 MW capacity’, they say. ‘Certainly, we can keep the target at 6,000 MW.’

At this point I need to introduce several technical details as well as numbers and facts. These will demonstrate the lack of integrity in leading the public to believe in nonsense, and - adding insult to injury - to have to pay for this nonsense out of its own pocket.

As envisaged, the total project would consist of several wind farms on the Dutch shelf in the North Sea.

1. The total electricity consumption of the Netherlands in the year 2005 was produced with an average aggregate power nearing 13,000 MW. Of these 13,000 MW, 20% was imported from Germany, Belgium and France. (About one-third of this was produced by nuclear power plants.) Thus the Netherlands itself produced with a power of roughly 10.400 MW.

It would be logical that 6000 MW coming from the North Sea would be supplied to the westernmost industrialised and most densely populated part of the Netherlands: the coastal region.
With ‘favourable wind conditions’, the full 6,000 MW wind energy would necessitate shutting down about 60% of the Netherlands’ total power plant capacity. This would mean all the power plants from north of Amsterdam down to the province of Brabant on the Belgian border, plus the three power plants near Utrecht in the centre of the Netherlands. Imagine what would happen if the wind force fell in a short time to below Beaufort 4. (In July and August 2003 we had almost complete calm on the whole North Sea for a period of three to four weeks, and for two week in July 2006. This proves, of course, that even on the North Sea the wind varies strongly. Any sailor can confirm that.)

These facts and numbers demonstrate what folly a 6,000 MW wind farm would be. With absolute certainty it would be the source of enormous blackouts that would spread to neighbouring countries, and probably even over a large part of Europe.

2. The proponents of this idea state that these 6,000 MW would come from 3 MW wind turbines: thus, from 2,000 wind turbines. Hence, just one maintenance/service visit every three months would mean 8,000 annual trips to the turbines in the North Sea alone. This amounts to 22 trips per day, or 30 per working day, the whole year through and irrespective of the weather conditions.

3. Transporting the produced electricity from each of these 2000 turbines to shore seems complicated, so let us assume that the current from groups of about 20 turbines (totalling a capacity of 60 MW) is connected via a switching station with a large transformer that raises the voltage such that it is suitable for further transport. Let us assume it is to 380 or 400 kilovolts (kV).
Each of these 100 switching and transformer stations has, therefore, a switching installation at least 60 metres long. Thus, along with an enormous transformer, at least for every group of 20 wind turbines a huge platform would need to be built, high above the maximum level of the waves and with completely watertight housing for the switching installation and for that extremely large transformer. Let us estimate a platform with a minimum total length of 70 metres. This means that at least 100 of these platforms would need to be built, totalling a length of at least 7 kilometres out there in the North Sea.
And remember: not a single kW would be produced as a result of all these complicated and extremely expensive technical necessities.

4. Now we have about 100 large high-voltage 60 megavolt-ampere (MVA) capacity transformers out there at sea; these should be connected somehow to a huge high-voltage switching yard somewhere on land. It would be the largest switching station ever built in Europe. But how? One hundred 380 kV power lines strung above the North Sea are surely cumbersome. Hence, 100 of the strongest existent high-voltage direct current cables (HVDV cables) must be used. This means that both at sea and on land 100 gargantuan semiconductor converters need to be installed to transform alternating current to direct current, and vice versa. For this, more platforms - all with watertight housing - have to be constructed.

5. Because they involve highly complicated electro-technical issues, I will not delve into the almost unsolvable problems relating to the supply of reactive power to this complex of 6000 MW.

Certainly a great deal more could be said. The above is simply an overview and intended to inform interested readers about the *real* facts surrounding the issue of wind turbines. What I have presented here demonstrates how the most improbable ideas continue to be spread regarding the usefulness of extensive offshore wind energy. Over the past few years, millions of pounds sterling have been spent just to keep the ball rolling, because every conference, every impressive brochure written by so-called specialists, represents a monetary gain for them. And the citizen, the private consumer, is forced to pay for all this by way of an inflated electricity bill.

A warning from Lord David Howell, former president of the BIEE (British Institute of Energy Economists)

International Herald Tribune, London (Thursday, December 23, 2004, page 8)
Windmills just won't get it done
Energy Crunch
By David Howell

Western governments are proving astonishingly slow to face up to the four-pronged energy crisis that lies ahead and which could in due course engulf them:

* World consumption of fossil fuels is soaring when it should be falling.
* Dependence on supplies from politically unreliable and unstable regions is increasing when it was meant to be diminishing.
* Carbon emissions from burning fossil fuels are expanding worldwide when they should be shrinking.

Investment in alternative energy sources is at best marginal, with the one really major source of clean energy, nuclear power, being held back in most countries by political pressures.
All these trends are heading the wrong way, and their effects may unfold on different (and maybe quite unexpected) time scales. World oil consumption is officially 80 million barrels a day, compared with 60 million in 1980. But

the real figure could well be higher, some say as much as 84 million barrels a day. Without radical policy changes, world consumption will be 122 million barrels a day within two decades, the International Energy Agency says.

The second crisis springs from the first. By 2030, the energy agency estimates, more than half the world's supplies will originate from shaky and troubled regions. But events will not wait until then.

Two decades ago Margaret Thatcher was dismayed to learn that 14 percent of Western Europe's gas imports were from the Soviet Union. Today, 40 percent comes from those regions, and the upheavals in Ukraine, which is crossed by pipelines carrying much of this huge volume, give a whiff of what is to come.

As for oil, consider the sources of what are supposed to be huge future supplies. Iraq sees its pipelines blown up almost every day. Iran may yet be the scene of another war. Saudi Arabia is under attack and wobbly, and unease runs through most of the other Gulf states. The Russian oil industry is in turmoil, and in other Central Asian producers and the various pipeline transit states like Georgia and Ukraine, the political landscape is generally volcanic.

Nigeria has strikes and sabotage, Sudan is at war, Venezuela is politically unsettled and Algeria still has a bad dose of Islamic fanaticism. Libya may be on the path of virtue, but it is too early to be confident. The golden age of North Sea oil and gas is drawing to an end, and Britain will shortly become a net importer once again.

The prospect might be manageable if governments were all set firmly on the path to a cleaner and greener energy future.

Europe has tried, with high taxes and the new system of carbon emissions "trading" — though even in Britain, carbon emissions rose last year, when they should have been falling, and the government now reluctantly concedes that its goals for emissions reductions are being missed.

But these noble efforts are dwarfed by opposite pressures elsewhere. China is building 60 new coal-fired stations a year. America is still relying on coal for over half its electric power while drinking more oil than ever, helped by gas-guzzling SUV's. Energy issues received hardly a mention in the recent elections.

Acres of giant wind pylons, the current Great Green Hope, cannot conceivably fill the gap. The one obvious alternative, nuclear power, remains largely stymied by politics. China may have bold longer-term plans for new plants. But elsewhere, nuclear programs have been in limbo for years. In Britain, a pioneer in civil nuclear power, the policy is to phase out nuclear capacity altogether, though the nuclear option is still claimed to be "open."

Yet the plain truth about the world's energy future is that the massive electric power that industry and 21st-century life need will have to come increasingly from nuclear energy if it is not to come from coal, oil and gas. The experts know this, as do the technicians. But do the politicians dare to break the news to a still nervous public, or will they wait until the lights go out, industry seizes up and governments are bundled from office by angry and frightened voters?

Advisers to President George W. Bush are said to be warning him that America needs a radically new energy policy. They are right. So do we all.

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Lord Howell, former British energy secretary and President of the British Institute of Energy Economists, is Conservative spokesman on foreign affairs in the House of Lords.

Eye opener in *Time* (April 3, 2006)

Lord Howell's convincing observations were confirmed by an extremely informative article in *Time*. *Time* wrote in bold letters:

"India's greenhouse-gas emissions could rise 70% by 2025.
The increase in China's emissions from 2000 to 2030 will nearly equal the increase from the entire industrialized world.
China's total electricity demand will rise an estimated 2.600 gigawatts by 2050, which is equivalent of adding four 300-megawatt power plants every week for the next 45 years.
India's energy consumption rose 208% from 1980 to 2001, even faster than China's, and nearly half the population still lacks access to electricity."

This is alarming information about the need for electricity, but the reality is at times even worse. For instance:

- For the production of every quantity of electrical energy, say a kilowatt-hour, about twice that energy coming from some sort of fuel is needed. This is because the thermal efficiency of most power stations is lower than 50 percent;
- The numbers that *Time* mentions refer only to the need for electrical energy, but today there are still more than four billion people that make use

of other and more primitive forms of energy: cooking meals by burning wood for example, or for heating and so on. This of course is also a heavy burden on our fuel resources.

Kyoto: Facts and Fiction

The Kyoto Protocol, signed in 1997 by 84 countries, is a fact. It states that our planet has entered a period of global warming mainly because of the increasing emission of carbon dioxide (although according to the rigorous rules that govern scientific debate it has not been proven conclusively). Anyone with reasonable knowledge about that extremely complicated phenomenon 'climate' - and who delves into the reports about the Kyoto debates and afterwards - might easily conclude that the views of the sceptics were overruled in an unsavoury and unscientific manner by the people who considered themselves the majority. But a scientific problem can never be considered 'solved' simply by counting the votes. (Remember how Galileo Galilei was treated by a politically motivated majority.) Graphs of the cyclic activity of the sun have shown for centuries a remarkable conformity with the temperatures of the earth.

The present book is not the appropriate place to discuss this complicated but important subject. However, one thing is clear:
If the sun were the culprit, nobody on earth could do a thing about it. But if the carbon dioxide (CO_2) emissions were the reason for global warming, tempting visions of wealth and political influence begin to emerge. This is certainly also why attendees at the conference in Kyoto ignored the fact that ordinary water vapour (i.e. clouds) is a much stronger greenhouse gas than carbon dioxide. Hence, the tale was then spread worldwide that building wind turbines would benefit the public purse, national politics and perhaps even humankind in general.

The dogma 'Never tell the full truth about wind energy' remains strictly observed by people who are maintaining a hidden agenda. A complicated system of trading 'emission rights' was invented and became a new commodity in the financial market. For national economical reasons, the countries who emit the most carbon dioxide do not participate in this trading system, such as The United States, China, India, Australia and Canada.

Global energy problems: What should be done?

Firstly, the problem must be taken seriously by the international community, not only by co-operating governments but also by the general public. People must not be coerced to believe that all sorts of pseudo solutions will provide the answer. On the contrary, they should understand how enormous the problem is. The public must be informed truthfully and with no concealment of the facts, regardless of the disapproval of politicians.

Secondly, the general public needs to be convinced by honest and complete information that everyone can contribute personally by saving fuel and reducing carbon dioxide emission, and at the same time save money directly for themselves.

Certain situations seem to border on insanity:
-The USA with about 5% of the world's population uses approximately 25% of the globally produced energy.
- American and European car manufacturers have only recently begun to understand that they will lose their battle against the makers of more fuel-efficient cars in Japan, in South Korea and, in a few years, in China. It seems that the US public still thinks that bigger, heavier and flashier means better.
- A friend of mine recently had to change his ticket at Miami Airport. He noticed that the girl behind the desk had an electric heater blowing near her legs.
He asked, 'Why that heater?'
She replied, 'It is so miserably cold here because of that horrible air-conditioning!'

How to reduce carbon dioxide (CO_2) and fuel emission: Suggestions for major and minor solutions

Considering the aforementioned situation regarding the information in *Time*, it is clear that only nuclear power stations and the most modern coal-burning power stations will be able to meet the demand for enough electricity to supply worldwide needs. This is why at the moment many dozens of large nuclear power stations are either in construction globally or are nearing the start of building. The large French-designed 1600 MW nuclear plant in Finland,, will most probably become the standard for Europe. France is building a similar reactor in Flamaville near the Atlantic coast These plant's carbon dioxide emission will be nil, and it can produce the same amount of electricity - with great security of supply - as 2,100 wind turbines of 3 MW capacity and having no security of supply at all.

Likewise, coal-burning power stations will be of modern design (using gasification of coal) and will have a strongly reduced CO_2 emission. These are the 'big boys' that will carry the weight of producing electricity.

As to becoming conscious of the need to save energy, it is a good sign that today every design of a product or industrial process is aimed at energy efficiency. Statistics in Europe already indicate a substantial reduction in used energy per ton of product in comparison to the numbers of 10-15 years ago. This change is evident especially in the heavy industries like steelworks and in the chemical and biochemical industries.

A great deal more could be done, however. For instance:

1. It would be expensive, but it is certainly possible to upgrade some of the older steam turbines in the UK's power plants in such a way that their thermal efficiency would improve markedly. An increase in every percent of the efficiency of the UK's entire electricity production would mean a 460 MW increase in reliable production capacity (the capacity of 613 3 MW wind turbines);
2. More power plants could be built to co-generate heat and electricity, e.g. heat for industries or central heating for consumers in towns;
3. More waste-burning power stations could be built for 'sustainable', or even 'renewable energy', that is produced in a reliable and uninterrupted way;
4. The use of heat pump installations could be recommended. This could also be practiced to heat the cooling water at the output of power plants. Normally, the cooling water is released into the sea or a river. In the Netherlands, in The Hague, a new residential area of 300 houses will receive its central heating the whole year round from a large heat pump installation that extracts heat energy from the North Sea. This is really renewable energy! Heat is also contributed by a gas-burning boiler;
5. More use could be made of geothermal heat sources. Again in The Hague, water at a temperature of about 80º Celsius will be pumped up from a depth of 2000 metres and also used to centrally heat a residential area. The water will be pumped back to its source. Also a real renewable energy.. This method is also used in Germany, France and Italy;

6. Everywhere in the world it could be recommended that air conditioning only be used for cooling when the temperature in a living or working area is above 25º C. Nobody dies of heat exhaustion at these temperatures. (A lower temperature would, of course, still be needed in hospitals and/or similar institutions.) Moreover, turning up the air-conditioning thermostat would give better and cheaper results than building dozens of huge power plants.

7. Statistics indicate that between 8 and 10 percent of the global consumption of electricity is used for lighting. This means that changing from the use of incandescent light bulbs to the use of leds (light-emitting diodes) will result in a considerable reduction in global electricity consumption.

For comparison: Lighting with incandescent light bulbs: from every Watt about 95 percent is lost as heat. Every Watt produces only 10 lumen/Watt . A led loses only 5 percent as heat, 95 percent is converted into light with today about 50 lumen/Watt. But still further improvements are reached in the laboratories.

8. More use should be made of tidal energy.

Countless methods exist that help reduce energy consumption. However, it is essential to realise that many ostensibly brilliant ideas generate only minimal and mostly unreliable and random results. This has been made abundantly clear in the previous sections of this article.

In summary, this argumentation only skims the surface of the multiple issues that surround the use and purported advantages of onshore or offshore wind energy. Nevertheless, on the basis of the factual data presented here I hope that the reader will be able to arrive at an informed and intelligent conclusion.

The only things you need to remember is:

the formula $E = f.m_{spec}.v^3$.

and

intended telling a half truth equals telling a whole lie

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Appendix:

What is a heat pump?

A heat pump functions more or less like a reverse-functioning refrigerator. A refrigerator has a radiator at the back, and that radiator is hot to the touch. Why? Because the 'heat' of the content of the cooled interior is 'pumped out' and, together with the used electrical energy, is released by the radiator.

A heat pump uses the 'heat' of the used source (for example, seawater) and together with the used electrical energy results in a higher and more useful temperature. The seemingly strange thing is that when the difference between the temperature of the used energy source (in this case the seawater) and the temperature at the output is not too great a heat pump will have an efficiency of more than 100%; in some cases even far more than that. This is because at the output we 'catch' the input energy plus the used electrical energy.

There is an amusing anecdote about how a heat pump was used during the Second World War. Switzerland was suffering from a severe lack of fuel, and so a huge heat pump was built on the embankment of the river Limat in the city of Zürich. The Limat functioned as the energy source, and with the produced heat a great part of the Technical University, the ETH, was heated. This resulted in a somewhat comical juridical battle between the Kanton of Zürich and the Town of Zürich. The Kanton demanded that the Town pay for the energy that it extracted from the Limat, which ran through the Kanton.

Suggested reading

1. *Wind Power and the UK Wind Resource*, a misleading report published by the Environmental Change Institute of the University of Oxford. This document is viewable at http://www.eci.ox.ac.uk/renewables/IKWind-Report.pdf;
2. The *E.ON Wind Report 2005.* This report is viewable at http://www.wind-watch.org/documents/eon-netz-wind-report-2005/;
3. *E.ON Netz Wind Report 2005 shows UK Renewables Policy is Mistaken,* a report published by the Renewable Energy Foundation (REF) in London. This publication is viewable at http://www.ref.org.uk/images/pdfs/eon.2005.REF.pdf;

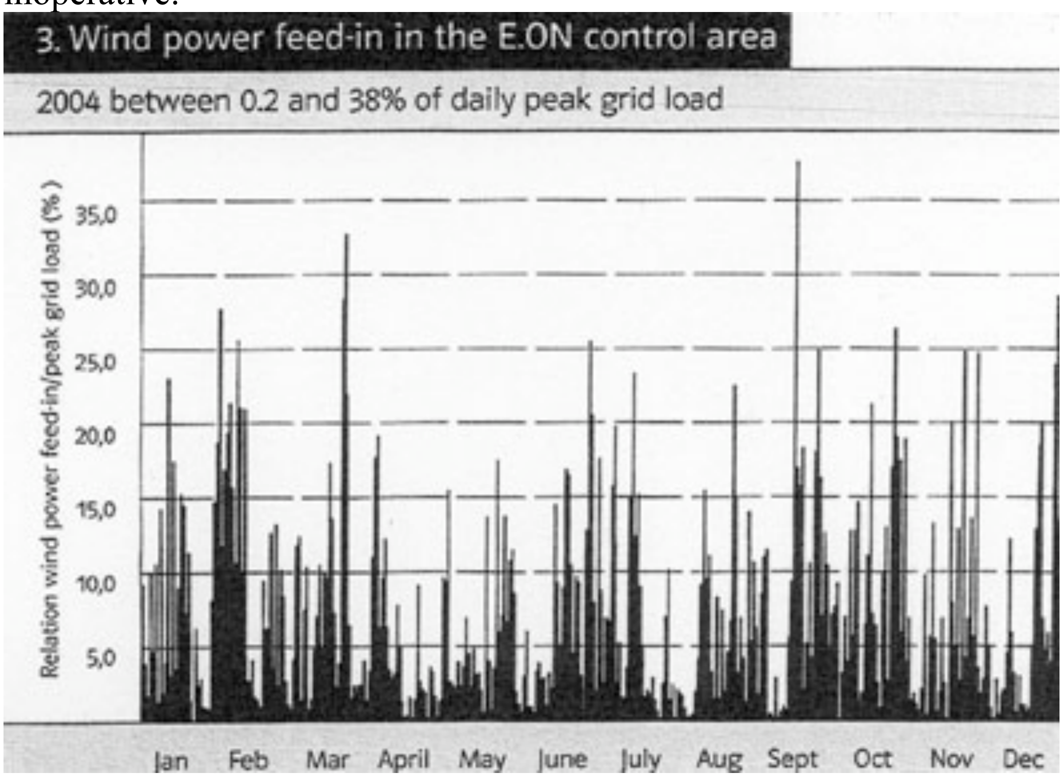
4. The October 2004 issue of the leading technology driven journal *Modern Power Systems*; about Horns Rev offshore wind park
5. The July 2006 issue of the UK magazine *Economics and Energy.* A critique of the report by the Environmental Change Institute of Oxford University: *Wind Power and the UK Wind Resource*
http://www.eci.ox.ac.uk/renewables/ukwind
6. For an extensive list of documented wind turbine-related accidents (some fatal) in the period 1975-2005, see http://www.caithnesswindfarms.co.uk.
7. 'A problem with windpower' by Eric Rosenbloom.
http//www.aweo.org/ProblemWithWind.html

(On the back cover of the booklet)

Wind energy

The formula ***E = f. m. v³*** indicates how the kinetic energy (***E)*** of wind, as the driving force of a wind turbine, is dependent upon the tiny specific mass (***m)*** of air and upon the cube of the low velocity ***(v)*** of wind. An understanding of the consequences of this natural law make it clear that a wind turbine - no matter how ingenious its design - will never produce a substantial amount of electricity in a reliable and consistent manner.

This book explains how each property and inherent disadvantage of a wind turbine is governed by this immutable formula, despite what advocates of wind energy tell the public. Every number mentioned in this book confirms the unavoidable facts.
As is to be expected, a physical law, a Law of Nature, can never be made inoperative.



The uncontrollable variations of the aggregate power of 7000 wind turbines widely dispersed in Germany over many hundred thousands of square kilometres.

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