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European Energy policies

10 questions, 10 answers for the future

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The European energy question is crucial but complex. It can be summed up in 10 important questions and their answers:

1) Power gap: when and how important?
2) Energy resources: for how long?
3) What about renewable energies?
4) What about sustainable energy economy and savings potential?
5) What about future technologies, notably hydrogentechnology, cold or hot fusion, superconduction and generation IV nuclear technology in which there are a lot of hopes?
6) What are really the accident risks?
7) Does Europe risk a **Political crash**: or a political dependency on its energy suppliers?
8) Does Europe risk an **Economic crash**: and what would be the economic and social consequences in Europe and in the world?
9) Does Europe and does the world risk a **Climate crash** through greenhouse gases?
10) What are the burdens we are passing on to the next generations?

These questions consequently lead to the following core question : what are the most urgent measures needed in Europe to avoid the 3 following crashes: political crash, economic crash, climate crash?

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Foreword

On the 8th of March 2006, the President of the European Commission José Manuel BARROSO presented a Green Paper on the "European Energy Policy"[1]. Three months after the oil crisis provoked by Russia and very close to the Brussels European Council (24-25 March), the energy problem starts to distress the European Union, giving birth to a variety of analyses[2].

The Commission's Green Paper opens up an interesting public debate that must be watched closely. It treats six priority domains: "an internal energy market", "solidarity among the member states", "durable, efficient, diverse energy sources", "issues tied to the global warming", "new energetic technologies and strategies" and "a common foreign energy policy".

Now, we can ascertain that we have entered in an era of "expensive oil", increased by the "gas war" which started last winter due to the ongoing conflict between Russia and Ukraine. We now can understand the important role Moscow is going to play in the energetic future of Europe[3]. Hopefully the Commission will take the whole matter seriously.

But in the article associated with the Green Paper's inauguration – published in many European journals – signed José Manuel BARROSO and Andris PIEBALGS, European Commissioner for the Energy, we can read the following astonishing lines: "Europe needs to set the framework for different low-carbon energies to thrive. For some, that might mean wind power, for some, solar power and for others, clean coal. Some member states are considering the further development of nuclear power. We do not have the luxury of promoting one energy source to the exclusion of others"[4].

Wind power, solar power, clean coal and in the end, almost hidden, the nuclear power! What a surprising change, and what a curious denial of the truth!

The reality: this is the quality of the paper presented by Hildegard von LIECHTENSTEIN. In ten questions and ten answers,she scans the European energetic situation:

- The oil and the gas? We know these resources are limited: we must control its utilisation in the energy making processes.
- The coal? Still inexpensive, but a big pollution source.
- The renewable energies? Even if it is desirable to exploit all the sources and to enhance the research work in order to obtain some significant results, it is an illusion to think that wind power or solar power can cover rapidly an essential part of Europe's energetic needs.
- The nuclear power? Though having a bad reputation in most of the countries, reunites two major qualities: it produces low-cost energy and can assure an energetic independence of the EU countries.

We are on the eve of a century where the energy will be the most important stake on the international stage, and we cannot neglect this argument.

This seventh paper of Thomas More Institute is a paper of advocacy, an appeal for realism and political courage, a *vade mecum* for the lucid heads

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[1] See http://europa.eu.int/comm/energy/green-paper-energy/index_en.htm.
[2] See Christophe-Alexandre PAILLARD, « Quelle stratégie énergétique pour l'Europe ? », Notes of Fondation Robert Schuman, N° 30, January 2006, www.robert-schuman.org.
[3] It is interesting to know that José Manuel BARROSO is going to have a meeting in Moscow with president Putin in order to present him the leads of European thinking, before the 24-25 March European Council. See« EU leaders urged to protect energy supplies », *Financial Times*, 7 March 2006.
[4] « Europe's energy challenge », *International Herald Tribune*, 8 March 2006.

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Hildegard von LIECHTENSTEIN

The public debate in Europe centring on energy production and the problem of global warming caused by the greenhouse gases associated with it began years ago, namely in connection with the rejection of nuclear power by public opinion and the desired or hoped-for substitution by alternative energy sources. More recently, owing to the dramatic increases in the price of energy, particularly for petroleum and its products, the discussion has been relaunched.

The furnishing of energy is subject to various constraints: security of supply, geopolitical risks, profitability, vulnerability to accidents, climate protection, safeguarding of the environment, the water supply, and the countryside.

The European Commission states in connection with the precautionary principle: "The determination of an acceptable level of risk represents a decision involving high political responsibility". However, it is not merely the risk – in particular that relating to the security of supply – which must be thrown into the balance, but also the concerned public itself.

Democratically elected politicians are, naturally, forced to amend their political viewpoints in accordance with public opinion, and those wishing to promote nuclear power must strive to achieve a social consensus. Particularly in a democracy, new technologies cannot be introduced against the will of the citizens. However, the latter gauge the risks of energy systems not so much by the intellect, but rather by the emotions, and in view of the complexity of the material this is understandable. Seen from a rational standpoint, however, it leads to atrophy of the political decision-making process, since effectively, the public is making two contradictory sets of demands:

The population desires:

a) Security of supply;
b) Low energy and petrol prices;
c) Economic stability;
d) Climate protection, i.e. alternative and renewable energies;
e) Protection of the countryside.

The population rejects:

a) Nuclear power (except for France partly) ;
b) Greenhouse gas emissions;
c) A substantial financial and personal effort to save energy at home or otherwise in the personal sphere;
d) Price increases for energy resources (heating oil and petrol), and likewise;
e) Price increases for most consumer products, food and household articles;
f) Increases in taxation and in the sums required to fund research, alternative energies and energy conservation measures, for example in public buildings;
g) Spoiling of the countryside through wind farms, reservoirs (pumped-storage hydrostations), high-voltage transmission lines, power station buildings, etc. according to the NIMBY[5] principle.

These diametrically opposed demands result in paralysis of political discussion, and in veiling and false information tactics on the part of interested groups. NGOs such as Greenpeace are exploiting the situation to pursue their own agenda.

Rational discussion is hampered, for one, by the complexity of information from science, technology, research and industry, and for another, by consciously misleading information and emotional influence exerted on the public by the political pressure groups.

To re-establish the freedom of decision making in Europe, it is essential to explain to the public in clear terms the dramatic situation we shall have to face in Europe in the next 5-25 years regarding the supply of energy. If the

[5] "Not in my backyard".

necessary decisions are not taken within a very short time, it will be impossible to maintain the quality of life, let alone to raise it in Europe as a whole.

Over and above that, it is necessary to consider existing global interrelationships. The decisions of individual countries have little or no effect on fuel reserves or their prices, nor do they have any influence on national economies, or on the CO_2 content of the atmosphere.

Time is running out! In 5 years' time it will probably be too late to take action to avoid either an Economic crash, a Climate crash or a Political crash or all three at once.

1) Power gap: when and how important ?

Every European country is anticipating importing its electric power from abroad – but who will be there to export it?

The power gap in Europe is a certainty, the only remaining question is: when? Future energy consumption and the ability to produce energy depend on many different factors: the demographic shift, growth of the national economy, the weather, the availability of primary energy, and the prospects of sensational technological innovations.

Together with France, Switzerland is in the most favourable position where the security of supply is concerned. However, even this country must import power from France in the six winter months[6]. Production shortfalls are anticipated within the next 7 years, especially if, as in 2005, negative factors intervene such as low precipitation in summer or the extended shutdown of nuclear power stations for technical reasons.

Over the next 15 years, Switzerland and the whole of Europe will experience ever increasing production shortfalls. Large production capacity will be taken off the grid in all countries, partly when plants reach the end of their working life, and partly for political reasons, not least owing to decisions to step out of nuclear power. By 2020, replacement and additional capacity needs of 300 000 MW are anticipated. This is equivalent to the electricity production of 375 large gas combi plants.

In Switzerland, which is in a comparatively favourable position, the power gap already amounts to 15-33 % of anticipated consumption in 2030. In Europe as a whole, the situation is much worse.

It must be feared that even if the availability of new plants such as the EPR[7] is taken into account, France will soon require all its generating capacity for its own needs. What is more, none of the remaining West European countries will be able to produce sufficient power to cover their national needs.

It is absurd to hear the ministries responsible for energy supply in practically all European countries reckoning with importing electricity to cover their capacity deficits. Power imports from whom?

To cover the electricity production shortfalls caused by the shutdown of nuclear power stations in Germany and Belgium by substituting it by imports from abroad (whereabouts abroad?) is simply an illusion. The idea of closing the gap within the foreseeable future by means of heavy investment in renewable energies is certainly worth considering, but from a practical standpoint must remain illusory. After the next cold winter following on the heels of a dry summer we will– at the very latest – again need to give serious thought to this problem.

2) Energy resources : for how long?

At this point, we shall discuss only those energy resources that may be employed on a large scale to cover base-load power requirements. Types of energy production that are only applicable in the distant future, or can only contribute a small percentage to base-load requirements, will not be able to fill the looming power gap in Europe, and need not therefore be discussed here.

[6] In winter, the availability of hydropower declines
[7] European Pressurised Reactor.

	Petrol	Natural gas	Coal	Nuclear	Hydro	Renewables
Fossil fuels (in 2004)						
World reserves	17%	17%	66%	-	-	-
World consumption	43%	27%	30%	-	-	-
Global energy consumption – Today						
	36%	21%	23%	7%	2%	11%
Global energy consumption – extrapolated to 2030						
	35%	25%	22%	5%	2%	11%

The scenarios for future European energy consumption differ widely. However, they all predict a staggering increase in the consumption of fossil energy resources in Europe, finally reaching almost 90% of total world energy requirements (see, for example, *World Energy Outlook 2004*[8]).

Petroleum – Petroleum is a raw material. Burning it is irresponsible. Half the world's reserves have already been used up.

Some 10% of current oil consumed serves as a raw material for fertilizers, plastics and insulating materials in the chemical and pharmaceutical industries.

Wold oil consumption

Goods and passenger transport	52%
Industry (energy and raw material)	24%
Household/heating	15%
Power production	9%

Peak oil production

Global peak somewhere	between now and	2020
North Sea oil, UK	peak was in	2002
North Sea oil, Norway	peak was in	1997
USA	peak was in	1973

Oil reserves available until

North Sea oil	2015
Central Asian oilfields	2015
World	????

The percentage contribution of petroleum to the world reserves of fossil fuels amounts to 17%, but its percentage of world *consumption* to 43%. There is no real substitute and the world reserves will begin to decline in 5 to 10 years.

One-half of the Earth's oil reserves have already been used up. The available statistics on the reserves – both from the petroleum industry and governments – should be regarded with caution, since for many years the oil producing countries have heavily exaggerated the reserves for political and economic reasons[9]. The physicist Kjell Alekett estimates that 10-15% of the quoted oil reserves are simply not there[10].

Peak world oil production predicted as early as 1962 by the geologist M. King Hubbert will be upon us in 5-10 years. No more do the calculations made by the geologists and physicists Colin Campbell and Jean Laherrère paint a rosy picture, predicting a world oil peak in 2016, and outside the Middle East as early as 2006! After that, oil production will decline and prices sharply rise.

In the petroleum industry and the OPEC countries in particular, there is broad agreement that it will be increasingly difficult to raise oil production, or even to maintain it for very long at present levels. Moreover, the

[8] Annual report of the Economics Analysis Division of the International Energy Agency (see http://www.worldenergyoutlook.org).
[9] For example, to raise their apparent percentage of total OPEC oil production.
[10] Those who still have no misgivings about rising heating oil and petrol prices should consult www.peakoil.net and www.oilcrisis.com/laherrere !

reserves in all oil producing countries are already so heavily depleted that the costs of exploiting the remaining oil – already very high – are constantly increasing.

In the middle term, the costs of production will in any case rise drastically for the simple reason that the exploitation of oil sands, or oil from deep-sea platforms, costs substantially more than 1$/barrel, the current price for crude from numerous wells in the Middle East.

Where our future and that of our children is concerned, the significance of petroleum as a raw material in the chemical and pharmaceutical industries for the manufacture of fertilizers, plastics and insulating materials, is greater than as a fuel. Whilst oil can be substituted as a source of energy – and this is advisable for environmental reasons – it is irreplaceable as a raw material.

By 2035 at the latest, i.e. within the next 30 years, the use of oil as an energy resource will have to be cut down to a minimum. From then onwards, oil production is expected to decline to 30-40% of the present level.

Natural gas – Higher energy yield but …natural gas is likewise an important raw material, and total dependency on Russia is indefensible

In comparison to oil or coal, the energy yield of natural gas is substantially higher, and the environmental impact from greenhouse gases significantly lower, particularly compared to coal. Especially in Europe therefore, a heavy increase in the consumption of natural gas is expected. The price of natural gas has increased in parallel to that of oil, and thus provides no protection against energy price rises.

The reserves of natural gas and its availability are comparable to those of petroleum. It is anticipated that it will be available for about another 60 years. However, in view of the fact that the annual increase in the consumption of natural gas is approximately 2-3 times higher than for total energy consumption, this figure must be regarded with caution. Furthermore, there are serious grounds to mistrust Russia's assurances on its long-term ability to deliver. The state company Gazprom possesses the export rights for 90% of Russian gas. Despite that, the profits from sales have not led to any investment in exploration or the infrastructure, an essential condition to ensure uninterrupted long-term supplies.

Natural gas is itself a valuable raw material. In Germany, 44% of the natural gas marketed is used in industry for the production of plastics, fertilizers and chemicals used in pharmaceuticals.

The EU – particularly in Germany – is presently investing abhorrent sums in expanding natural gas generating capacity and the infrastructure. However, the reserves of natural gas in Europe (outside Russia) will be exhausted within the next 10 years. Thus in 10 years' time we will be 100% reliant on the dependability of Russia and North Africa as energy suppliers.

Coal – Cheap, large reserves, but …the world's greatest polluter

Coal is present in most continents and world reserves are still high. Estimates indicate that it will last for another 200 years, even taking into account that India and China consume steadily increasing quantities. These two countries alone account for 40% of world consumption, their needs having doubled in the last two years.

The increase is due to a large extent to the extreme expansion of steel production, for which coke is employed. Moreover, electricity generation in China relies to almost 70% on coal-fired power stations[11]. Thus China is already the world's largest polluter of the environment, and this is already being felt as far away as on the West Coast of the USA.

Added to that, the demand for coal in Western industrialised countries is increasing in response to the heavy increase in the price of natural gas. But despite the soaring price of coal over the last two years, it is still cheap in comparison to other energy resources. In the USA alone, it is planned to have 92 new coal-fired power stations on stream within the next two years, and a total of 148 new thermal power stations by 2025.

It is estimated that the consumption of coal for electricity production will rise over the next 10 years by 40% to 50%. Politically, this is a catastrophe, since coal, and particularly lignite, is the no.

[11] In the USA and Germany the figure is approximately 50%

1 polluter amongst fossil fuels, causing substantial "collateral" damage to health and nature. In addition, the production of hard coal involves a heavy toll in the mines.

Unfortunately, Europe is not in a position to prevent other countries using coal to generate power, and this applies particularly to the USA and China, neither of which have signed the Kyoto protocol. As long as the avoidance of CO_2 emission through "sequestration" is technically out of reach. At least Europe should renounce the use of coal as a fuel, since based on our infrastructure and advanced technical know-how, we are well in a position to generate power that is free of CO_2 emission. This is particularly true of Germany.

Nuclear energy – Stepping out is more risky than stepping in Nuclear power is sustainable

Worldwide, the percentage contribution of nuclear energy to electricity production is 17%, in Europe 33%, in France 85%, in Germany 28%, in Switzerland 43% and in Austria, Belgium, Italy and (soon) in Sweden 0%. Whilst the Germans have decided to step out, the English are still undecided.

Regardless of that, all countries intend importing nuclear power to compensate their own inadequate supplies, enabling them to provide the population with the necessary quantities of energy at the much lower cost of nuclear power. France is the only country in a position to export electricity summer and winter from its own nuclear power stations. A warning example is Italy with its existing power gap and dependency on energy imports. There, one large electricity utility intends to purchase three nuclear power stations from France.

The secure world reserves of uranium are 3.5 million tonnes. Uranium ores are widely distributed over the globe, and the actual reserves are significantly larger[12]. In Australian uranium mines, natural reactors have been found to occur, so that the use of nuclear energy can be said to be a natural process that occurs in nature without human intervention. Furthermore, nuclear power as practiced today utilises only 2% of the uranium, the remainder being passed on for terminal disposal. This material is a valuable source of energy, and it will not be long before it is recovered from temporary storage to be reprocessed and further exploited for power production.

Enough uranium is available for hundreds of years, or provided that we invest in research and use only the most advanced technologies.

3) What about renewable energies?

For domestic heating: yes – Decentralised demands in small proportions: yes – Electricity production: no (Exception: hydropower).

Percentage contribution to EU electricity production	
Renewables (including hydroelectricity)	14%
Nuclear power	33%
Fossil fuels (oil, gas, coal)	53%

Percentage contribution to German electricity production	
Renewable energies (Wind 4.4%; biomass 1.3%; photovoltaics 0.1%; hydropower 3.7%)	9.5%
Nuclear power	27.8%
Fossil fuels (lignite 25.6%; hard coal 22.3%; natural gas 10.4%)	58.3%

The purported "substantial increase" in the contribution of renewables to electricity production has been hailed by some politicians as a *success story*. In reality, the increase represents only a few percent of total consumption and involves heavy expenditure. Although Germany leads the field in wind power and solar energy, its percentage of renewables is only 5% of total consumption, and was achieved only by investing billions.

In fairness, the substantial costs of maintaining reserve capacity with this form of power generation[13] and its integration in the existing distribution system should be added. Also, many advocates of green power overlook the fact that considerable losses are involved in transmitting electricity over large distances.

[12] The IAEA estimates 15 million tonnes.
[13] The wind does not blow continuously, etc.

Without doubt, renewable energies do have their special charm and are practically risk free. However, even if many, many billions of Euros were soon to be invested in research and the development of renewables, they would still be quite insufficient to cover Europe's base-load, as can easily be deduced from the figures for Germany (as an example).

To this must be added the giant space requirements for hydropower, wind power and photovoltaics. With wind, the infrasound problem and spoiling of the countryside are not to be forgotten. Furthermore, not all renewable energies are as sustainable and free of greenhouse gases as hydro (or nuclear) power. They are, however, ideally suited to reducing the consumption of heating oil and natural gas in private households, whereby the emphasis here should be on exploitation of geothermics and biomass. The use of biomass to substitute fossil energies is however subject to narrow limits in Western Europe owing to the high population density in this region. To illustrate this, I shall take the example of France, which disposes of much larger open spaces than other European countries. **To convert the total needs of car traffic to oil seed, France would require an area of more than 100% of its total land area[14].**

Even in countries in which the geographical and hydrological situation permits[15], hydropower is the only source of renewable energy able to cover the base load of the electricity utilities[16]. Unfortunately, hydropowers, and especially the pumped-storage stations, have recently met with active opposition from those responsible for water conservation and countryside protection organisations.

Wind power – Too scarce. Too expensive. Too ugly. Too loud

An EU energy policy report states that in 15 years, 20% of energy needs will be based on renewables. Applied to wind power, this would mean 20 000 giant wind turbines spread over the European countryside. To this must be added the problem of transport: Germany is already hard pressed to transmit the power produced in the North Sea and the Baltic to the heart of the country.

Wind power is seen by some politicians, particularly in Switzerland[17] and France, as an alternative to current electricity generation, so that I shall discuss this here in more detail.

The trailblazer in this form of energy production is without doubt Germany. Thus of the approximately 33 000 MW installed worldwide, Germany accounts for 14 000 MW. In 2002, one-half of all new world wind capacity was installed in Germany. With this modest contribution of a maximum of 5-6% to total power production, the new era of wind power has already reached its apex, since stormy sites are rare. The same is true of Switzerland and Austria. France and Great Britain are lagging behind in this respect, but geographically, these have scope for expansion. Nevertheless, no more than 5% of Europe's total energy consumption can be expected from this source.

In 2004 alone, Germany subsidised the regenerative energies to the tune of 2.2 billion Euros. Producers of wind power get about 8.5 cent per kWh delivered to the grid. This is almost three times the price of energy from other sources. Wind power is a classical example of 'subsidy cavaliering' paid for by the hard-working taxpayer.

Renewable energies should mainly be used for substituting heating oil and natural gas in buildings. Since approximately one-third of total energy consumption is attributable to domestic use including building heating, these are ideal candidates for the substitution of fossil fuels needed to meet the demands of the Kyoto protocol within a relatively short period. As a general principle, further development and use of renewable energy sources is to be strongly recommended, particularly for decentralised energy requirements in agriculture and private households. With decentralised applications it is easier to achieve profitability, and these may also be utilised in the African countries.

At present, the expansion of electricity generation from renewables to a level around 15 or 20% is completely illusory[18]. It is entirely unthinkable that they could now replace nuclear power. Likewise, it will not be possible in the foreseeable future to achieve a substantial reduction in fossil fuels for electricity generation. This does not

[14] EDF sources.
[15] Countries with mountains and sufficient water.
[16] In Switzerland approx. 60%.
[17] Rudolf Rechsteiner, an swiss SP National Councillor, is one of the most active (see : http://www.rechsteiner-basel.ch)
[18] Excluding hydropower.

exclude the possibility that in fifty to a hundred years' time a significant percentage of our energy supply could come from renewables.

The use of renewables is only sustainable where the electricity required in their production comes from CO_2-free sources. In Europe, only Switzerland meets this criterion[19].

4) What about sustainable energy economy and savings potential?

In a sustainable energy economy, the principal sources of supply are: wind and water power, solar thermal, photovoltaic, wind and tidal energies, geothermics, biomass (right through from household waste to pellets), and above all nuclear energy. The costs arising from the exploitation of these energy sources (except for nuclear power) are substantially higher than for direct production from fossil materials.

Measures to conserve energy and its efficient use are therefore the most important aims in a sustainable energy economy. They must be applied to all stages of the process from production and conversion through to distribution, storage and use of energy.

Sustainability – It is urgent to stop using fossil fuels for electricity production. Nuclear energy will be irreplaceable for many years ahead

What is meant by "sustainability"? How is it defined? How can it be measured? The physicist and politician Dr. Rolf Linkohr[20] defines it as follows: "Sustainability is understood to mean that we should act in such a way that not only we ourselves, but following generations will be in a position to satisfy their needs. In the wider sense, sustainability demands equal treatment of all countries and human beings through the generations, whereby economic growth, environmental conservation and social justice must equally be taken into account. All three requirements must be brought into balance with one-another. There is no unique criterion for sustainability".

- **Economic growth as yardstick**: Where the costs are concerned, all of the fossil energy resources are comparable. Their limited long-term availability and dependency on politically unpredictable suppliers make it vital to phase out electricity generation based on petroleum and natural gas.
- **Environmental protection as yardstick**: The most important factor in gauging environmental viability is the quantity of CO_2 and other greenhouse gases arising from energy production. Lignite is by far the worst candidate in this respect, since apart from carbon dioxide, it emits large quantities of sulphur and nitrogen oxides that threaten health. It is also responsible for acidification of the soil. In comparison to lignite, coal is not quite as disastrous. The assertion of some politicians that electricity may be generated from coal free of CO_2 is at present simply dishonest. Technically, the sequestration of CO_2 will not be possible until 2020 at the earliest. Its implementation in coal-fired power stations will hopefully be available by 2030. The environmental situation is similar with petroleum, and very slightly better with natural gas. Common to all fuels is that they produce exceedingly high quantities of greenhouse gases. The two exceptions are nuclear energy and hydropower, both of which produce no or only very slight CO_2 emission.
- **Social justice as yardstick**: Due to high consumption, the prices of petroleum and natural gas on the world market are driven upwards. The industrialised countries can still more-or-less afford these – but those who are poor can no longer afford to buy oil. From the viewpoint of social justice, therefore, the cost of energy must be as low as possible.

Based on the above sustainability criteria, only nuclear energy and hydro power prove significantly more favourable than oil or natural gas, not to mention coal or – worse still – lignite. Indeed, nuclear energy is more sustainable than some renewable energies, for example solar systems, when the entire energy chain is looked at.

[19] See Table supra.
[20] Former member (SPD) of the European Parliament, former Chairman of the European Energy Foundation in Brussels.

Savings potential – Very important, very expensive, very long-term

Several different scenarios on future energy consumption are making the rounds in the EU, all of which continue to predict a substantial savings potential of some 20%. Corresponding programmes[21] being promoted by governments focus on building renovation, more efficient use of energy in industry, and goods and passenger transport.

Households, the service sector and manufacturing industry each account for one-third of electricity consumption. The energy intensive industries had already introduced substantial economies following the oil crisis in 1973, so that further economies of anything more than 10% cannot be expected within the next 10 years. When these industries reach the limits of their economisation potential, and the pressure of costs becomes too large, they will simply move to other countries. In households, which consume a further one-third of the electricity, the price of electricity represents only a small part of the cost of living, so there is little incentive to conserve it, and significant reductions cannot be expected. The same is true of the service sector.

In our societies, there is nevertheless a savings potential of about 10% in electronic appliances. Both in households and particularly in the administrative and service sectors, a high percentage of the electricity is used in electronic data processing (EDP), particularly for display screens[22]. EDP accounts for up to 60% of the electricity used in offices.

For heating oil, savings are more difficult to achieve. Although excellent mini energy building designs and heating systems exist, they are only appöicable to new buildings.

The big drawback of savings strategies: to close the power gap, all American, Russian and European towns and cities would either have to be rebuilt, or their heating systems replaced!!!

With transport, the problems are no less daunting, and are only soluble over the long term. Note that only about 37% of the cars on the roads are new, whilst 30% are more than 10 years old. **Thus if only diesel hybrid cars and electromobiles were to be permitted from tomorrow onwards, it would take until 2025 for all existing vehicles to be replaced.** With air traffic, drastic economies are only to be expected in panic situations such with the SARS virus or avian influenza.

Since they will only take effect over a longer period, energy saving measures must start now. In fact, the long-term economic potential of measures for conserving electricity and heat is greater than the middle-term potential of renewables.

5) What about future technologies?

Hydrogen, the great illusion...

Hydrogen is not an energy resource, but an energy carrier. Huge(70%) energy is wasted by fuel-cell cars. The cost corresponds to a petroleum price of 200$/barrel. The some 200 million cars on the roads in the USA consume about two-thirds of the oil. Experts and lay persons alike experience the exhaust gases from these as obnoxious. Also, the recent enormous rise in the cost of petrol is a painful experience to consumers. The idea of substituting petrol by a completely clean and 'natural' substance such as hydrogen, whose combustion product is pure water, sounds very attractive. The problem with hydrogen is that it does not in fact occur naturally , but must first be produced, for example by electrolysis or steam reformation. To do this, more energy must be invested than is later got back, with an overall efficiency of only 60%.

To produce and compress hydrogen, or – worse still – liquefy it, requires enormous quantities of energy. In converting it to electricity in fuel cells, e.g. in cars, only about 30% of the energy in the fuel is recovered. The materials used also require large amounts of energy to produce. Moreover, hydrogen is highly volatile and flammable, and thus an accident risk. The transport of hydrogen, both in pipelines and cars (to supply the fuel cell), and its distribution to filling stations, is therefore a demanding technical task.

The energy source used to produce the hydrogen decides the extent to which a fuel cell is clean or dirty in operation. For fossil fuels, the total result is dirtier than burning petrol directly in an Otto motor. With respect to

[21] For example SwissEnergy.
[22] Companies can reduce their electricity costs by approx. 10% simply by switching off screens during the longer breaks.

CO_2 emission, the use of solar electricity to produce the H_2 is no improvement on a modern diesel hybrid vehicle. In fuel cell vehicles, the energy conversion losses are about 75%, whilst the transmission losses of electricity average only 10%. Thus there is not the slightest reason to first store electricity in the form of hydrogen and then to convert it back to power under very high loss. Solar energy should preferably be input direct into the grid.

The use of hydrogen technology for transport in Europe would be a gigantic waste of energy.

With hydrogen cars, only about 40% of the energy input is available at the wheels, whereas with electromobiles the figure is 80%. To add to that, electricity from the wall socket in the garage is much cheaper than hydrogen from the filling station. In Europe, 3 billion Euros are to be pumped into hydrogen technology over the next 10 years, with no hope of return of capital, and in complete ignorance of the physical conditions**. The future belongs to electromobiles and diesel hybrid cars.**

The real technologies of the future:

Hot and cold nuclear fusion – Early last year it was decided that the research centre for nuclear fusion ITER would be built in France and would begin its work in 15(!) years' time. The interval between the discovery of the radioactivity of radium by Marie Curie in 1898 and the first large nuclear power station of 35 MW in England was almost 60 years. By the year 2050, we will certainly not have a fusion reactor available for electricity generation – if ever … I am somewhat more optimistic – despite the evidence to the contrary – in respect of cold fusion, which incidentally, would be much less dangerous. Unfortunately, research in this field has almost come to a standstill. The two most prominent American scientists in the field were subjected to harassment by their colleagues at MIT under unusual circumstances.

Superconduction – With electricity, supply security suffers, among other things, from the problem that the energy cannot be transported loss-free. This problem, and that of producing electricity at places very remote from the user, could be solved by superconduction, making possible nuclear power stations in uninhabited regions, solar electricity from the Sahara, tidal electricity and wind power from Ireland, etc… Very promising – perhaps realisable in 30 years' time – but at the moment only possible in the laboratory at -100°C.

Generation III and IV nuclear installations – Nuclear technology can look back on an extensive period of development in which several different technological paths have been pursued. Thanks to over 10 000 years of reactor operating experience, the safety standards in current generation II reactors are very high. Based on this technology, generation III was developed, the most well known example of which is the new EPR (European Pressurized Water Reactor) built by France in Finland. The system is not only notable for its higher standard of safety, but also for its shorter erection time, lower operating cost and improved fuel utilisation. The first of these reactors was taken into service in 1996, and some 100 are now in planning or being built the world over. With the new generation IV APS now in development, transition to a sustainable nuclear economy should be within reach.

The principal advantages of the new technologies are:

a) significantly higher safety, ensuring that accidents affecting the population resulting from physical causes may be excluded;
b) significantly reduced quantity of radioactive waste;
c) several orders of magnitude lower isolation times (i.e. significantly reduced half-life) of the waste in terminal storage;
d) improved utilisation of the fuel (80% in place of 2%);
e) as a result, conservation of uranium reserves.

Amongst the available technologies of the future (including hydrogen), generation IV nuclear is the only technology that can be introduced with certainty within a fairly short period.

6) What about accident risks?

Nuclear and hydropower are safest.

In Switzerland, the Paul Scherrer Institute has built up the world's largest database, ENSAD[23], on serious accidents associated with energy production. This shows on the one hand that most accidents involving fatalities arise in the mining, processing and transport of fossil fuels. Over 100 000 deaths result each year from explosions (of liquid gas), accidents in mining and oil platforms in the sea, and pipeline ruptures.

In sharp contrast, the lowest death rates are found with Western hydro and nuclear power stations. To my knowledge, no fatalities - due to radioactivity in a Nuclear Power Plant - have ever occurred in Western nuclear power stations – not even during the notorious reactor breakdown in Three Mile Island (Harrisburg) in 1979 in the USA.

Notwithstanding these facts, our citizens are fearful of nuclear technology. Trust in a technology cannot, of course, be achieved by reason or statistical data. The public demands safety, requiring at minimum an assurance that the nuclear installation in their vicinity is safe. If the public paid attention to risk analysis, they would no longer step into their cars, but take an aircraft; they would give up smoking, not marry, not do the housework, nor do sport, but confine themselves to gymnastic exercises.

This raises the question as to whether a technology exists with which no accidents can happen. The safety in Western nuclear plants has at any rate improved to such an extent over the past decades that even in the improbable event of a serious accident, the effects would be restricted to the interior of the plant: no radioactivity at all could escape to the environment. With the newest generation IV APS, a large-scale accident involving an uncontrolled chain reaction and core melting can be excluded on physical grounds.

7) Does Europe risk a political crash?

For China, wars to secure energy supplies are certainly an option.

Securing the raw material supply of a country rests on two main pillars: maintaining access to the site of production, and safe transport home of the materials. These involve not only economical, financial and technological aspects, but also diplomatic, political, through to military aspects. Usually, we are confronted with a combination of all of them.

The rapid economic development in Asia, and particularly China[24], has produced dramatic competition for raw materials on the world market. The Chinese and Indian governments are making intensive efforts to secure the raw material basis essential to their industrial development. China has now become the second largest consumer of petroleum after the USA, at present importing one-third of its total needs, corresponding to 40% of the additional world requirement for crude oil. Likewise, India imports 70% of its fast-growing oil needs. In parallel, the reserve capacity of its oil producers shrank to 2%, a value well below the traditional figure of 20%.

This situation has led to massive geopolitical tensions, particularly with the USA. Attention has recently awakened to the lively activity of China in Africa[25] with its raw material bounty, from whom it already imports some 30% of its petroleum, a rate that is fast increasing. In 2000, the government in Peking inaugurated the CACF (Chinese-African Cooperation Forum), in which 44 African countries are participating, with the aim of gaining substantial political and economic influence in Africa. This is facilitated by the extreme corruption prevalent among African governments. One of China's principal partners in Africa is Sudan, a government under political quarantine in the West in the wake of the Darfur genocide. American firms are prohibited from investing in Sudan. The Chinese, of course, are perfectly happy, having poured over 15 billion Dollars into Sudan over the last 10 years for pipelines and oil exploration. The takings have enabled Sudan to massively increase its arms purchases

[23] See http://www.psi.ch
[24] See « Hydroelectricity in China : new energetic politic and hydropolitic stake » of Valérie Rivière in *La Revue Française de Géopolitique* (n°2-2004, *Géopolitique de l'énergie*, p209-231)
[25] Particularly in Angola, Sudan and Congo

Particularly those African regimes that have recognition problems in the West, and/or problems of authority in their own countries, will welcome China's support. A typical pre-colonial situation!

However, it is not only in Africa and the Middle East[26] that China is encroaching on the interests of the USA, but also in Latin America, Iran, Pakistan and South-East Asia. Thus to safeguard its transport routes through the Straights of Malacca and Taiwan, China has emphasised the necessity of expanding its navy. Moreover, it has clearly been made known by the Chinese government at diplomatic level that nothing will stop it from acquiring the needed resources – and above all fossil fuels – by all means at its disposal …

Europe's political dependency on its energy suppliers – The simplest method to paralyse Europe within hours would be for Russia to close the gas cock.

As mentioned above in the chapter on energy resources, our European gas and petroleum reserves will be heavily depleted in the next 10 years. In consultation with the USA, it will be necessary to secure our petroleum supplies well beforehand. Petroleum and the refinery products derived from it can be stored fairly easily. Minimum supplies are always at hand, not only to nations as a whole, but to industry and the households (in the form of heating oil) as well. A much greater concern is the dependency of Europe on Russian[27] supplies of natural gas. Germany's natural gas imports already derive to 35% from the tundra, with an increasing tendency, and the figure for the new EU member states in the East touches 100%.

In December 2004, the International Energy Agency (IEA) in its report on energy policy warned of this dependency and drew attention to the necessity of diversifying natural gas imports to assure the security of Europe's supplies. The plans approved by German Chancellor G.Schröder and President Vladimir Putin for the construction of a further natural gas pipeline under the Baltic Sea give grounds to fear that the enormous risks of becoming dependant on the reliability of supplies from an authoritarian state have been recognised neither by Western politicians nor by the general public. Above all the red/green groups are urging an increase in the contribution of natural gas to total supplies.

Naturally, the new EU-countries in the East take an entirely different view. Mr Lech Kaczynski, who won the recent presidential elections in Poland, has declared the problem of energy imports to be a matter of public security, his primary economic policy objective being to find alternatives to Russian supplies. Poland is still in trauma following Russia's dispute with White Russia in 2004 on prices, in which Russia simply cut off supplies to the White Russians, thereby severing the supply to Poland. The same can happen to us.

Warsaw was recently flabbergasted when the Russian foreign ministry endorsed the decisions of the Yalta Conference (1945), involving the sovietisation of half of Europe. This should concern us.

The geopolitical independence of operators of nuclear power stations stands in sharp contrast to this. Uranium ores are present in all continents, and ready-made fuel elements may be stored for years in a relatively small space. Fuel reserves for 5 to 10 years may be conveniently held in stock without the need for substantial investment.

8) Does Europe risk an Economic crash and social unrest ?

Prices for all sources of energy will converge in the long run. There will be no inflation but : low growth at first, then stagnation, then recession, and then …? What we need is inexpensive power!

As we saw in the previous chapters, the gap between world energy supplies on the one hand, and energy consumption on the other, is constantly widening. From this, the conclusion must be drawn that in the long run the price of energy will tend to move in one direction only – namely upwards. The prices for individual energy resources will of course continue to vary cyclically. That is to say, having reached its peak of approximately 70 $/barrel, the price of oil will probably decline temporarily, later to reach a price of perhaps 100 $/barrel in the middle to long-term.

[26] From where China still obtains over 45% of its petroleum.
[27] « Energy and Russia » in *La Revue Française de Géopolitique* (n°2-2004, *Géopolitique de l'énergie*, p 183-207)

In the past, the price of oil displayed the greatest volatility, attributable to political causes, among them the formation of cartels. In general, however, the price of oil correlates strongly with that of gas and coal. This in turn leads to a correlation with the input price of renewables to the grid. In the short term, the elasticity of the consumer price for energy will remain low, so that the market price for primary energy will continue to fluctuate heavily. In all other markets, the demand for a product declines immediately as soon as the cost rises significantly: this is not the case for the energy market. However, in the middle to long term, private and industrial consumers will be able to replace their energy suppliers in relation to price and supply, so that all energy prices will tend toward the same levels.

When the influence of rising energy prices on present-day national economies is looked at, one sees a significant difference to the world of 1973, when the oil crisis led first to inflation and then to stagflation. Today, the situation is quite different, with inflation appearing unlikely. For one, owing to the partial loss of influence of the trade unions and to higher productivity, the pressure of costs is lower, and for another, present-day consumer prices are subject to increased pressure from market globalisation. With declining world economic prosperity, the competitive pressure on Western producers will increase: since China (for example) is more likely to lower its export prices than its export volume. Effectively, we are now living in a deflationary world.

Energy prices have a marked influence on the growth of national economies. Thus in the industrialised countries, for each 1% growth in the GDP[28], energy consumption rises by 1%. If the high level of energy consumption can only be maintained at much heavier cost, this will strongly retard national economies. In 2005 alone, the world economy grew by 1.5% less than its full potential. In the coming years and decades, the lack of inexpensive energy resources will lead to stagnation and recession.

The results of this are well recognised :

- Lower income available for domestic consumption;
- Declining standard of living;
- Loss of employment;
- Dangerous overloading of our social systems;
- Growing tensions within society;
- Growing protectionism of sovereign nations;
- Growing foreign tensions;
- Rapid deterioration of the profit margin (margin squeeze) in companies;
- Declining industrial investment;
- Declining investment of highly indebted states;

The consequences amplify one-another in fatal ways.

Under these global conditions, additional problems will result for sovereign states from their own energy policy measures. If, for example, a state funds the development costs for renewables via the purchase price of electricity for both domestic and industrial consumers, such as in Germany, the resulting higher costs – up to twice the present level – will induce energy intensive manufacturing companies to move abroad, e.g. to Canada. **In this way, not a single kWh of electricity will be conserved. Instead, it will lead to disadvantaging one national economy (such as those in Germany, Austria, Denmark, etc.) to the benefit of another.**

The unreasonable distortion of energy markets through political actions, such as burdening consumers with the much higher cost of renewable energies, will not lead to less energy being consumed as supposed, but to energy being consumed at another point. Instead, it will result in massive distortion of individual employment markets, augmenting social tensions and the discrimination of minority groups.

This fatal situation can only be avoided by reversing the renunciation of atomic power, redirecting research funding from so-called hydrogen technology into new, safe and efficient nuclear power stations, and further expansion of pumped-storage hydropower in conjunction with nuclear energy, in the way of emergency and transitional measures, until such time as other competitive sources of energy have been found.

[28] In the developing countries by 40% more

9) Does Europe and does the world risk a climate crash?

The segregation and storage of greenhouse gases on a large scale is at present only a dream. Nuclear energy is the safeguard for the human species

Comparison of the average Greenhouse Gas Emissions in (gCeq/kWh) due to power generation by the different fuels[29]

Energy sources	CO_2 emission from power stations	+ other CO_2 emission	Total
Coal	246	24	270
Petroleum	163	27	190
Natural gas	109	21	130
Solar	0	30	30
Hydropower	0	19	19
Biomass	0	12	12
Wind	0	7	7
Nuclear Fission	0	4	4

In Hawaii, the concentration of the greenhouse gas CO2 in the atmosphere has been recorded since 1958. Research constantly reports new record levels, so that now the CO2 content of the atmosphere lies over 380 ppm (parts per million), a value more than 35% above the pre-industrial value, and the highest for 400 000 years. The rise is due to the activities of human civilisation. Although carbon dioxide is not the only greenhouse gas, it is by far the most important. Most of these gases arise through the combustion of fossil fuels. Thus even the most conservative estimates of global primary energy consumption predict a doubling of CO2 by the year 2050, resulting to 85% from fossil fuels.

In its report, the IPCC[30] warns that the CO_2 concentration will rise to a value between 450 and 550 ppm by the year 2050, a value that will increase further until the year 2100. Following the increase in temperature in the last century by almost 1 °C, it is anticipated that in the present century it will rise between 1.4 and 5.8 °C. Even on the most optimistic assumption for the temperature increase, this will have very serious consequences, e.g. melting of the glaciers (disadvantageous for hydropower), and a rise in the sea level (flooding of catastrophic dimensions). Further, how will the Gulf stream react when the icy waters of the Arctic no longer function as a mighty pump?

Today, there is much talk of so-called 'sequestration' of carbon dioxide during the process of energy production. Under sequestration is meant the separation, removal and storage of the greenhouse gases arising from combustion. All of the processes studied until now are either too hazardous (escape of the vast quantities of stored carbon dioxide to the atmosphere, and danger of asphyxiation in the region affected), or too energy intensive (the required energy is estimated at between 20 and 50% of the fuel energy, leading to almost double the rate of exhaustion of fossil fuel reserves).

In May 2004, the Society of German Chemists (Gesellschaft Deutscher Chemiker)[31] expressed the view that "natural" sequestration by afforestation would make more sense and be substantially less expensive to realise. From this perspective, it would be more beneficial to store biomass under oxygen-free conditions as a carbon sink than to convert it to electricity.

[29] Figures produced by The Profesor Rakesch Chawla, The Paul-Scherrer Institute, the 14 of October of 2004 during a conference on the occasion of the general meeting of the Nuklearforum Schweiz (http://www.aspea.ch) in Bern.
[30] Intergovernmental Panel on Climate Change of the UN.
[31] See http://www.gdch.de.

10) What are the burdens we are passing on to the next generations ?

Our children will despise us – and rightly so! We are poor custodians of their inheritance.

Greenhouse gases and climate change – Carbon dioxide has a very long life. The gas persists for hundreds of years in the atmosphere. Even if all the electricity were produced free of CO_2, (through substitution of fossil fuels by nuclear and hydropower), a substantial part of domestic fuel consumption were covered by renewables, geothermics, district heating from nuclear and biomass, etc., and of part of the fuel consumption for transport were used in hybrid cars, the problem would still persist for generations. Removal of carbon dioxide from the air and/or during production by sequestration is problematical, technical realisation not being possible in the immediate future. We may simply hope that it will be so within the next 20 years. Those who assert otherwise for political reasons are simply lying. A reduction of CO_2 emission can only be achieved within a global framework by the wealthy nations, the poor countries having insufficient means to do so.

In World Energy Outlook 2004 it is anticipated that in 2030 world energy needs will be covered to 90% by fossil fuels. A truly horrifying perspective! The ongoing process of climate change will have extensive repercussions on the settlement of the coastal regions, public water supplies, in agriculture and on public health. Added to that is the enormously increased risk of natural disasters. **Today, the point has been reached at which climate change can no longer be avoided: it might, however, be possible to limit it.**

Plundering of life essential resources – Regrettably, it must be assumed that in step with the price of energy on the world market and the political availability of this resource, we shall plunder all the fossil resources in turn until very little remains of them: what is left can only be exploited at very high cost. With oil and natural gas, the reserves will be exhausted in the next 50 years. This means that our own children – let alone our grandchildren – will hold us responsible.

Terminal storage of atomic waste – There are two recognised problems with nuclear power, namely the safety of the installations themselves and the disposal of the radioactive waste. Where the operating safety of Western nuclear power stations is concerned, this is greater than that of other technologies, and nuclear power now meets with less public opposition. The greater problem in the eyes of the public is the risk involved in terminal storage, although this could certainly be solved. So-called terminal storage 'forever' will never in fact be needed, since in traditional nuclear power stations, uranium is only exploited to 2% and represents a valuable source of energy for nuclear stations of the fourth generation.

We will not be able to afford to waste this resource. Thus 'terminal storage' should be seen more as intermediate storage pending reuse of the spent fuel elements following reprocessing by transmutation. If the energy industry should unexpectedly evolve in other ways, this would pose no great problem. Intensive research is now in progress on the treatment of radioactive waste, for example by optical and chemical methods, to neutralise the radioactivity within a very short period. **The burden of radioactive waste will not have to be passed on to our children.**

Political instability: wars of resources – As explained in Chapter 7, the global competition to secure resources will lead to extreme problems of political power. The greater the energy autonomy of individual countries and political power blocks, the easier it will be to avoid wars to secure the scarce energy resources.

It will also be very important that Western industrialised countries, who dispose of the technical know-how and superior political structures (corruption posing a safety risk), should exploit nuclear power to underpin their independence. This will reduce their call on world markets to cover their fossil fuels needs, mitigating competition for the ever scarcer raw materials. This in turn will reduce both their dependency on individual supply nations and their vulnerability to political and economic coercion.

Parallel to this, the renewable energy technologies must be further pursued where the geographical situation allows, such as in Europe, with its hydropower, wind energy, geothermics, solar energy, etc., although these alone are insufficient. We must act today to protect our children from war and avoid a political crash in the future.

Instability of national economies – As explained in Chapter 8, for many years employment has continued to decline in Western Europe through completely misguided energy policies. This tendency will be amplified still further by the expansion of the EU and the freedom of companies to shift production abroad. Industries that have emigrated to avoid political obstacles will never return. In this way, it will hardly be possible to maintain the standard of life of the citizenship, let alone achieve an increase in the *per capita* growth in income through national economic growth. The majority of the new EU countries have recognised this and are expanding their nuclear capacity. The consequences for Western Europe will be: social hatred, continued high loss of employment, drop in income of the groups affected and increased readiness of these to use violence. Do we really wish to become poorer?

Motivation and leadership will be required for an open debate on the advantages of nuclear Energy, as opposed to depletion and misuse of fossil fuel.

Conclusion

In closing, I wish to cite James Lovelock, the founder of the green movement, who writes in his foreword to Bruno Comby's[32] book: *Protection of the environment by nuclear energy*: "I hope that it is not too late for the world to develop nuclear energy as the main source of power. At present, there is no securer, more realistic or economical substitute for the dangerous practice of burning carbonaceous fuels."

At present, the only reason not to exploit this wonderful and inexpensive technology is public anxiety. Even so, anxiety can be repressed by other fears. Thus it is conceivable that the increasing fears of loss of employment, climate change and the risk of war could displace this anxiety.

My chief concern is that the anxiety of a drop in one's own personal standard of living could repress the fear of climate change, pollution of the air and of the environment!

[32] See http://www.ecolo.org.

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