15 Years After Chernobyl

Nuclear Power *AND* Climate Change ?

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"Shortly after the accident, in early May 1986, the IAEA Director General visited the Chernobyl plant, laying the groundwork for the world's first authoritative review of the accident at an international meeting at the IAEA in August 1986."

International Atomic Energy Agency (IAEA) News Briefs, February/March 2001

"Even if there was this type of accident every year, (...) I would consider nuclear power to be a valid source of energy".

Dr. Morris Rosen,
then Head of the Department of Nuclear Safety of the IAEA,
in August 1986[1]

The UK Food Standard Agency recently carried out an unexpected risk assessment. The question was whether sheep that are still affected by post-Chernobyl restriction orders that have also contracted the Foot and Mouth disease can be safely burnt or buried without leading to unacceptable air pollution or groundwater contamination from radioactive cesium. The result of the unpublished interagency analysis, according to an official familiar with the document, was that the "consequences on the food chain are negligible". A sheep farm in Cumbria, still suffering from the Chernobyl fall out, is now being investigated for Foot and Mouth.

Fifteen years after two massive explosions and a subsequent fire released a giant radioactive cloud into the atmosphere over the Chernobyl nuclear power plant located in what used to be the USSR, 388 farms with 230,000 sheep in Wales, England and Scotland are still subject to restriction orders. The contamination levels stand at several hundred Becquerels of cesium per kilogram of meat, too much to be consumed by human beings. The sheep have to be moved for some time to low or non-contaminated pastures in order to allow the bodies to loose some of their radioactivity before they can be slaughtered.

For many countries the 1986 Chernobyl catastrophe came a *public* turning point for the future of nuclear energy. In fact, while the UK contaminated sheep problem is only an example, the

real dimension of the disaster has never entered the collective consciousness until today. Over 400,000 people have been evacuated. Currently, and for a long time to come, up to 20% of the national budgets of what are now the Ukraine and Belarus are necessary to cope with the follow up costs of the drama. At least nine million people remain exposed to significant levels of radiation. Teenage girls in large cities like Minsk and Kiev wonder whether they should give birth. WISE-Paris' deputy director Yves Marignac visited Chernobyl in April 2000 on the invitation of the UN. He was shocked about the lack of funding for the UN's most elementary human aid programs in Ukraine and Belarus - impossible to raise $9 million as compared to way over $2,000 million spent on so-called technical nuclear assistance programs - although approved by several UN resolutions. Incidentally he also found out that top officials at the French radiation protection agency had never even heard of restrictions on sheep farming in the UK. In France post-accidental precautionary measures had been limited to the retrieval of a few tons of spinach while on the other side of the border German farmers had to plough under their harvest.

Chernobyl Out - Climate Change In? A bit of History First

Chernobyl happened a long time ago, Western technology is much better anyway and public attention has turned to Climate Change. Does nuclear power come back in through the window of opportunities provided by the - justified - collective fear of the greenhouse effect? "Commission grows more pro-nuclear". The emphatic headline in a major nuclear magazine introduces EU Energy Commissioner Loyola de Palacio's statements at the latest World Economic Forum in Davos, Switzerland. The Commissioner describes herself as "enthusiastically positive" on nuclear power and states that: "Giving up the nuclear option would make it impossible to achieve the objectives of combating climate change".

This is only the latest in a series of statements by the nuclear lobby - and the current EU Energy Commissioner is now clearly viewed by the nuclear lobby as representing the nuclear lobby - trying to imply that there would be no choice but going for nuclear if we are serious about the struggle against climate change.

The enthusiasm for nuclear power is not new. But it did not last. In the United States, where it started out with General Eisenhower's 1953 "Atoms for Peace" speech and the subsequent promise of nuclear electricity "too cheap to meter", the "civil" nuclear age was finished before the European one really started. The last American reactor order (which has not subsequently been cancelled as most of them) dates from October 1973. Only a few months later, the International Atomic Energy Agency (IAEA), with official status as a United Nations agency, put out projections for the installed nuclear capacity in the world for the year 2000 - that was yesterday. The Agency then forecasted up to a staggering 4,450 installed nuclear GigaWatt, corresponding to about the same number of 1,000 MegaWatt reactors. In reality, the number of operating nuclear reactors in the world reached its historical peak of 442 units in 1996. And the year 2000 facts are quite different from the 1974 IAEA forecasts: according to current IAEA figures, as of the end of 2000 the world counted 438 reactors with a total of 350 GW, less than 8% of the projected nuclear capacity. They produced about 17% of the world's electricity or about 7.5% of its *commercial primary* energy, far behind oil (40%), coal and natural gas (25% each). Nuclear power accounts for only 2% to 3% of the world's *commercial final* energy consumption.

Nuclear energy remains limited to a restricted number of countries in the world. Thirty-two countries, 17% of the 185 UN member states, operate nuclear power plants. The big five -

USA, France, Russia, Japan, UK - of which four are nuclear weapon states, produce 70% of the nuclear electricity in the world. The eight nuclear EU member states produce 34% of the world nuclear electricity. The historical peak of operating reactors in Western Europe and North America was reached in 1989. The decline of the nuclear industry, unnoticed by the public, started many years ago.

Table 1:
Number of nuclear reactors in operation in EU Countries (as of April 2001**),**
Share of nuclear in total electricity (in %, as of April 2000)

Country	**Reactors**	**Nuclear Share (%)**
France	58	75
UK	35	29
Germany	19	31
Sweden	11	47
Spain	9	31
Belgium	7	58
Finland	4	33
Netherlands	1	4
Austria	0	0
Denmark	0	0
Greece	0	0
Ireland	0	0
Italy	0	0
Luxemburg	0	0
Portugal	0	0
EU Total	**145**	**Ø 20 %**

© WISE-Paris Source: IAEA

In the EU, outside France, the last reactor was ordered in 1980 and even in France no construction site has been opened since 1993. On Christmas Eve 1999 this last nuclear power plant under construction in the EU was connected to the French grid. This means that currently there is no unit under construction or planned in Western Europe or North America. Whatever one might think of nuclear power, it is a fact that there are more reactors closed down than new ones being built. In other words: the tendency is going downhill. The Energy Information Administration (EIA) of the US Department of Energy forecasts a significant decline in the installed nuclear capacity in the world even under its conservative reference scenario. In its 1999 “minimum scenario” the US-DOE forecasts a decline of 49% in installed nuclear capacity until 2020. This might still be the optimistic scenario given the current trends.

European Politics and the Future of Nuclear Power

One has to carefully distinguish between existing reactors and future projects. Currently there is not a single new project in the EU. There are many reasons for the decline of the European nuclear industries. The main ones are lack of public acceptance, high investment costs and a very large installed electricity generating over-capacity in a more and more liberalised energy market. One should also emphasise that there are seven non-nuclear EU countries (Austria,

Denmark, Greece, Ireland, Italy, Luxembourg, Portugal) that play a significant role in the definition of a European energy policy.

Austria held a referendum in November 1978 - that is four months *before* the Three-Mile-Island accident in the US! - and decided not to open up an already built nuclear power station. One month later, Austria passed a law that effectively bans electricity production from nuclear fission reactors.
Italy in 1987, deeply shocked by the Chernobyl disaster, the people decided following a referendum to immediately shut down their four operating nuclear power plants and scrap the construction of five more reactors. Italy is the only former nuclear country, which has not produced nuclear energy since the Chernobyl nightmare.

The situation in each of the eight Western European nuclear countries is very different. However, in none of these countries are now any firm plans to build a new nuclear plant. The politics concerning the phase out of nuclear power are varying widely.

In the **Netherlands** a single remaining reactor is scheduled to be shut down in 2004. A "natural" phase out.
In **Finland** the discussion over the "fifth" reactor has been going on for over a decade. However, the country has a very high level of combined heat and power plants (about 40% of the electricity is produced in CHP facilities) and it has a significant share of renewable energy in its energy balance (in particular bio-mass and hydropower). The opposition to the "fifth" reactor has always been very lively. Its realisation, while not impossible, seems unlikely today.
Belgium's new government is based on a coalition agreement involving the Green Party that aims to limit the lifetime of the seven Belgian nuclear reactors to 40 years (shut down of the seven reactors between 2014 and 2025 at the latest). Belgium, formerly one of the most enthusiastic nuclear countries in Europe, today has a Secretary of State for Energy who used to be the Executive Director of Greenpeace Belgium.
Spain has had a moratorium on the construction of new nuclear reactors beyond the nine installed units for many years. New generating capacity is rather built on the basis of natural gas. Spain has also one of the largest wind power programs in the world.
Sweden has carried out a referendum in 1980 that limited the nuclear program to 12 units and a 30-year lifetime. It was not a phase out referendum, as widely believed, since construction of half of the reactors was not even completed at the time of the consultation. By 2010 all of the units were to be shut down. In the meantime, a government coalition compromise killed the 2010 deadline but agreed to start with the phase out much earlier. Therefore, the first reactor was taken off the grid before the end of 1999. Further planning depends on the demonstration of sufficient capacity and payment of compensation to the operating utilities.
In the **UK** the renewal of existing nuclear power plants has been a non-issue since the attempt to privatise the industry failed when the nuclear kWh turned out to be at least twice as expensive than publicly stated previously. The UK operates eight of oldest units in the world. The country has massively invested in gas fired power plants over the last 10 years.

In **accession countries** nuclear power is faring no better. In the ten countries currently preparing for joining the EU, there are only two reactors under construction, one in Czech Republic (Temelin 2) and one in Romania (Cernavoda 2). Furthermore, in the next decade ten reactors are destined to close – as part of the accession agreements.

The French Case - The End of the Old Dogmas

"'Nuclear Phase Out', without the least question mark." Dominique Voynet, the French Environment Minister was stunned: "I first wondered whether there was no error. After I had verified there was no mistake I wondered again: Were we really in France? And in Parliament on top of it?" It was not a dream. On 5 July 2000, the Vice-President of the National Assembly, Green MP Yves Cochet - now candidate for the succession as Environment Minister - had invited to a conference under the title "Sortie du Nucléaire" and everybody came. Speakers included the President of the State utility EDF (Electricité de France), which produces 75% of the country's electricity with nuclear power plants, and his administrative boss, the Minister for Industry.

When conference title and program were established, the organizers could not know that barely three weeks before, on 14 June 2000, the German government and the main electricity utilities would reach a "historical agreement on the progressive ending of civil nuclear power", as the daily *Le Monde* put it on its front page. Under the editorial's headline "Nuclear Power: The beginning of the end?" France's most respected newspaper stated that "this spectacular decision re-launches the debate in Europe and isolates France". The same day, the other French national liberal daily *Libération* started up an internet forum under the question "Shall nuclear power be phased out in France?"

In an inter-ministerial declaration in December 1998, the French government admitted for the first time that they went "too far" with their nuclear program. The share of nuclear energy would have to decline in future. Christian Pierret, Secretary of State for Industry, at the recent "Nuclear Phase Out" conference at the National Assembly went even further: "I am absolutely opposed to 'all-nuclear' (tout nucléaire). This is a message of evolution that I came to deliver to you. The promotion of renewable energies constitutes a fundamental re-balancing of our energy policy. This is an engagement that is voluntarily taken and with conviction."

According to a recent opinion poll in France, the Chernobyl accident remains the number one rated catastrophe in recent history and the strongest argument against nuclear power. A minority of the French trust the information given to them on the dangers of nuclear power plants (only 44%) and radioactive waste (35%). The following message, posted (in French) on the internet forum of the daily *Libération,* sums up well the mood in parts of the French population (and it is surprisingly close to the German Minister of Economy's statement hereunder):

> "Okay, yes, nuclear power exists. Yes, it is useful to France today. But everything should be done that tomorrow nuclear power will only be an ancient story. A story which, from one day to the other, can kill anywhere anybody without him even knowing."

France is far from an active "phase out" policy - yet. But the simple fact is that it became the consensus in France that there has to be other sources in its energy mix. More middle and peak load sources like gas and renewables which means that there is simply no need for any further nuclear capacity for a very long time to come. None of the future scenarios that have been established by an expert team appointed by Prime Minister Lionel Jospin envisages any new capacity before 2020. In the mean time, many parameters striving against nuclear power will be reinforced.

The German Case - The "Nuclear Phase Out" Plan

In October 1998 the current German government parties signed a voluminous 50-page coalition agreement that stipulates in the energy chapter that "the phase out of the use of nuclear power will be comprehensively and irreversibly regulated by law within this legislative period". In the parliamentary energy debate on 23 March 2000, Werner Müller, Minister of Economic Affairs and former utility manager, highlighted the key focus point:

> "Independently of the fact that they [the nuclear power plants] are most probably safe, it is entirely unchallenged that they are not 100% safe and that - even if this is highly unlikely - an accident could happen that would make this country uninhabitable. Against this background it is absolutely consequent that all sides - you, the industry and also the Red-Green Government - say: the question over the use of this energy can only be decided by the politicians."

As a preparatory significant step, the agreement reached between the German government and the main nuclear utilities on 14 June 2000 calls for the progressive shut down of the 19 German nuclear units. The calculation of the remaining operational period of the reactors is based on electricity production rather than lifetime. The anti-nuclear movement has harshly criticised the terms of the agreement for pushing the shut down of nuclear power too far into the future. But support to the agreement also collected about two thirds of the votes at the national Green Party Convention. However, the recent massive protests against shipments of radioactive waste from La Hague to Gorleben and the subsequent shipments of spent fuel to La Hague call into question the support for the "phase-out" agreement. Many people want to see nuclear power plants being shut down much faster than in the terms of the "consensus" reached between government and nuclear operators.

Nuclear Power *Against* or *in Addition to* Climate Change?

Today the key argument in favour of nuclear power is neither economic nor energy resource related it is the threat of global climate change. Nuclear power is seen by many as the only energy source with a large development potential and no greenhouse gas emissions. Says energy Commissioner Loyola de Palacio, nuclear power "helped the EU achieve its Kyoto Protocol targets regarding global warming, helping it avoid around 300 million tonnes of greenhouse gas emissions annually". This is a very common representation these days. But what is the underlying comparative calculation? If one is talking about "avoidance" of emissions through the use of nuclear power, it obviously depends on what the comparative energy policy looks like and what it costs.

Several preliminary comments are important here:

• The Commission's Green Book uses the figure of 312 million tonnes of avoided CO2 emissions in the EU per year through the use of nuclear power. The 312 million tonnes figure corresponds to an emission of 370 g/kWh of replacement power (843 billion nuclear kWh in 2000), which corresponds to the typical emissions of a combined cycle gas fired power plant. However, the 312 million tonnes would drop to:

- about **half**, if the natural gas plant chosen as replacement reference was co-generating heat and power;
- to **zero**, if the replacement was hydro plants;
- a **negative** value - nuclear power actually emitting more - for many energy efficiency options, for wind power and for various biogas solutions.

• The Green Book claims that the closure of the Swedish Barsebäck reactor would lead to a production short fall of 4 billion kWh per year and an "indirect increase in Sweden's CO2 emissions of around 4 million tonnes per year" through electricity imports from coal fired Danish and German power stations. The 4 million tonnes figure corresponds to a release of 1,000 g/kWh, which is indeed typical for a coal fired power plant.
However, the indication in the Green Book is grossly misleading because Sweden does not have a production shortage at all. In 1998, the year before Barsebäck was shut down, Sweden exported almost three times as much electricity (16.8 TWh) than it imported (6.1 TWh) or four times as much as Barsebäck's power output during the same year.

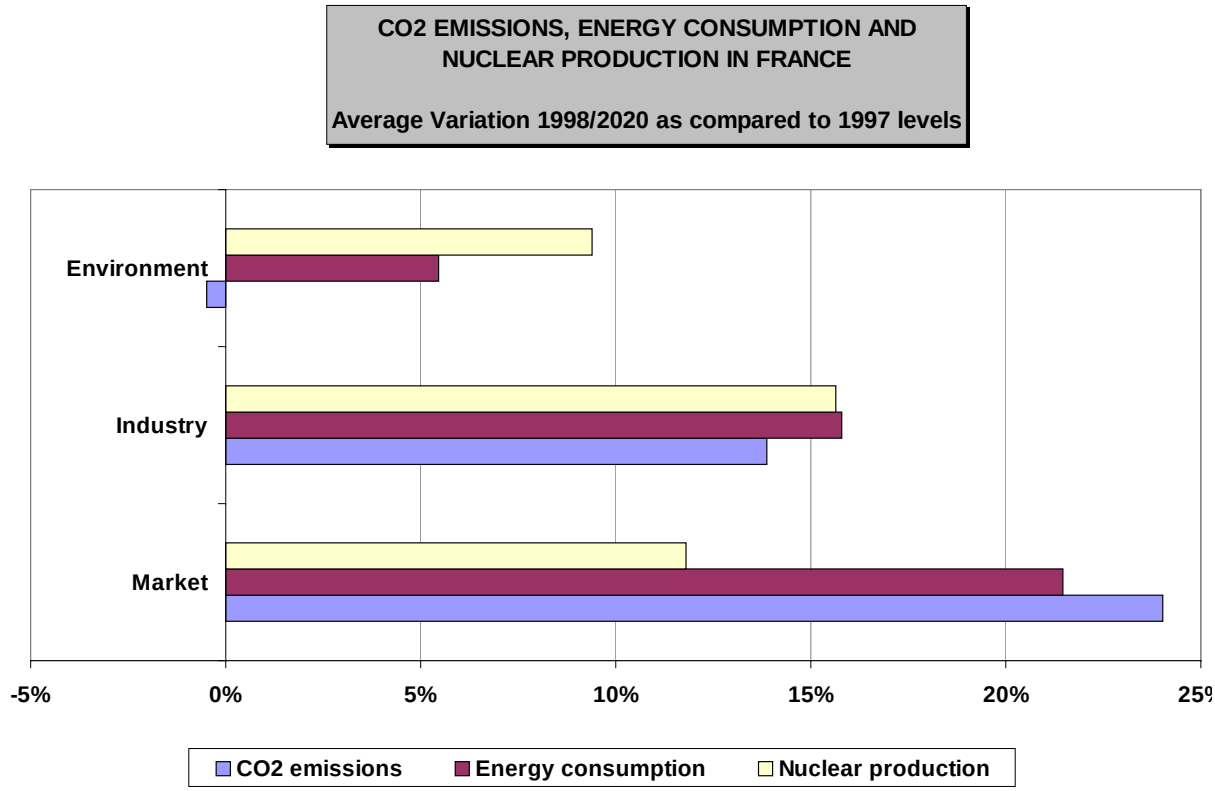
• CO2 is only one of the greenhouse gases. The other gases to be taken into account include in particular CO (carbon monoxide), CH4 (methane), N2O (nitrogen oxide). The emissions should therefore be expressed in CO2-equivalents, rated according to their greenhouse gas efficiency. While for many energy technologies the difference between CO2 and total greenhouse gas emissions are not substantial, in particular for some natural gas and coal technologies the CO2 equivalent can be 20% or 30% higher.

A closer look shows that the climate change argument fails to cover other essential points :

• Life cycle analysis of greenhouse gas emissions show that while nuclear energy emits about as little greenhouse gases as large scale hydro plants or wind turbines - and of course significantly less than coal fired power plants - it remains considerably higher than, for example, biogas co-generation facilities which produce electricity and heat at the same time with very low emissions

• While there might be some discussion about the economic performance of a part of existing nuclear power plants, there is no doubt that *new* reactors are economically simply not competitive with other greenhouse gas abatement strategies and notably advanced energy efficiency strategies. The in-depth analysis of three scenarios ("Environment": high energy efficiency, "Industry": State regulation; "Market": liberal) for 2020 carried out on behalf of the French National Planning Commission clearly shows that by far the lowest CO2 emissions are in the low consumption scenario (see figure hereunder). In other words, it is much more efficient to bring consumption down than to bring nuclear power up.

Figure 1: CO_2 Emissions, Energy Consumption and Nuclear Production in France
Average Variation 1998/2020 as compared to 1997 levels

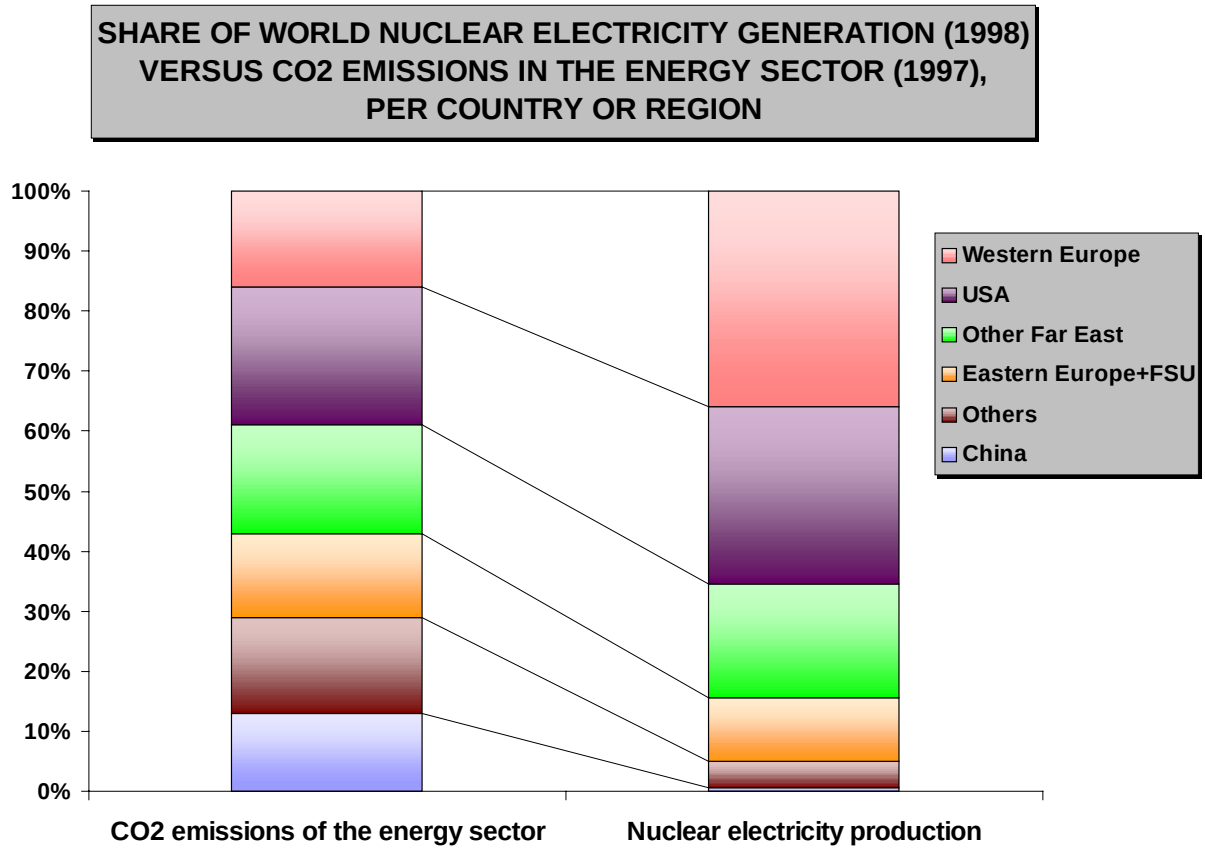


Quelle: Commissariat Général du Plan, Paris, 1999

• Unilateral reliance on nuclear power is far from being a sustainable CO2 abatement approach. France increased in a single year (1998) its national CO2 emissions by staggering 5%. Bad nuclear performance, high fossil fuel use, increase in transport emissions, was enough to shake up the "good" CO2 performance by France. In other words: the French system is extremely fragile and exposed to events with global implications.

• It is an interesting hypothesis that nuclear strategies have actually led to or are at least accompanied by high consumption patterns that lead to high CO2 emissions. It is striking that the regions and countries which are high nuclear electricity producers are in general also high CO2 emitters (see figure 2). This does not mean that the nuclear power programs in the given regions and countries are *directly* responsible for the level of *total* CO2 emissions indicated. The hypothesis is that there is a pattern of development, industrial growth and consumption that leads to energy systems favourable to nuclear power. And it is an old story that most of the planet's population uses the least energy.

Figure 2:



Source : UNDP 1999 ; IAEA 1999

What About the Energy Resource Problem and Energy Independence?

"The Limits of Growth" remains the most famous of the reports to the Club of Rome, published in 1972. It illustrated in a shocking manner the problem of limited resources within an economic development system of unlimited growth. In 1980, the 1,000 page international environmental report "Global 2000", yet commissioned by President Carter and painting a unique picture of the world wide decline of natural resources, reached an unprecedented 500,000 print-run in Germany. However, by the middle of the 1980s it became clear that the key limiting factor would not be the availability of energy resources but environmental degradation, first by acid rain[1] and then through global climate change. There is no doubt that the use of fossil fuels **must** be slowed down for **environmental** reasons much earlier than **any** current projections for consumption patterns would suggest.

There is also a widespread myth of so-called energy independence. The argumentation: we do not have neither oil nor coal nor gas, so in order to stay independent, we have to go for nuclear power. And where does the uranium for EU nuclear programs come from? It is correct to reply that there are diversified sources of supply and therefore there is some sort of supply guaranty. But what if the sources are decentralised, diversified, small scale installations with low capital cost, short lead times, high flexibility, low grid costs and phenomenal social acceptance? If technocrats and politicians were serious about the notion of

[1] During the 1995 World Energy Council Conference, I was surprised to realise that Japanese top officials were much more concerned by the threat of Chinese acid rain for Japanese rice fields than by global warming.

energy independence, why did they let the transport sector increase annual oil consumption by a quantity exceeding the oil savings through the implementation of the nuclear program, like in France?

International Developments Unfavourable to Nuclear Power

The total failure of the energy industries to anticipate consumption patterns and to rapidly adapt to new situations led to unprecedented over-capacity, in particular in the electricity sector. France has an over-capacity close to half of the installed nuclear capacity. Germany could shut down its nuclear plants tomorrow morning if it was only a matter of available capacity. The over-capacity in the Western European grid is estimated by the industry to reach 40,000 MW that is the equivalent of 40 nuclear reactors. This is probably grossly underestimated.
In Eastern Europe the situation is much worse. The decline in economic activity has led to a spectacular drop in energy consumption of the countries of the former Soviet Union in particular. Whether Russia, Ukraine or Lithuania, in all countries the drop in electricity consumption since 1990 by far outweighs the ***total*** national nuclear electricity production. In parallel, liberalisation of the energy markets in Western Europe has led to a spectacular decline in electricity prices (minus 30% on average in Germany within one year)[2]. In proportion, this tendency leads to an increased share of grid costs within the delivered power cost structure. The bigger the production unit the higher the distribution cost. The tendency therefore favours decentralised energy sources with low distribution costs, a highly underestimated factor in the debate.

Renewable energies meet an unprecedented development dynamic in Western Europe over the last few years. Germany has developed into the world's largest wind power generator with more than 6,000 MW installed and about 11 TWh annual production (equivalent to two nuclear reactors), increased by 1,600 MW. (2000). Some areas in Northern Germany now exceed 15% of wind energy in their power production. Much of this program has been initiated under the former conservative government. It is only one year ago that a new legislation on renewable energies was voted. It guarantees long term prices for renewable energy from various sources, a significant precondition of large scale and fast take-off. And on the international scale, the European Commission's development targets aim to double the output of renewables in the EU from 6% to 12% of the gross inland energy consumption as of 2010.

[2] In nuclear France, which has still only opened its market to a minimum level, the prices dropped only by 14% over the last four years. Since February 2000, State utility EDF lost at least five large industrial customers to other providers, including German and Spanish utilities.

Table 2: Targets for Renewable Energies in the EU
Share of Electricity Generated by Renewable Energy Sources

	1997 Real	2010 Target	% Increase
Austria	72.7	78.1	7
Sweden	49.1	60.0	22
Portugal	38.5	45.6	18
Finland	24.7	35.0	42
Spain	19.9	29.4	48
Italy	16.0	25.0	56
France	15.0	21.0	40
Denmark	8.7	29.0	233
Greece	8.6	20.1	134
Germany	4.5	12.5	178
Ireland	3.6	13.2	267
Netherlands	3.5	12.0	243
Luxembourg	2.1	5.7	171
UK	1.7	10.0	488
Belgium	1.1	6.0	445
Overall EU	**13.9**	**22.1**	**58**

The Key to Sustainable Energy Policy: Intelligent Efficiency and Energy Services

The heart of the energy debate will be energy efficiency. There will be no long term, sound renewable energy based system if it is not fundamentally anchored into an energy efficient approach. The efficiency potentials are enormous in most of the countries.
One should finally start doing fewer studies into the potentials and put more effort into the question on how they are supposed to be lifted. What are the policy implementation mechanisms that work? What are the barriers where it does not work? How to organize availability of capital for efficiency investments?

We need heat and cold, light and communication, not uranium, coal or electricity. A recent two year metering campaign by the OECD's International Energy Agency in the residential sector in France came up with the result that simply replacing the existing domestic electric equipment with the most energy efficient equipment available on the market today led to the result that it would allow 40% savings or 26 TWh or the equivalent of the production of four nuclear power plants.

The current dynamics in renewable energy policies are encouraging and problematic at the same time. If Government support leads to the installation of solar cells on a roof… that is not insulated, then we have a problem. In the end, it is not a matter of technology neither of economics but simply of human intelligence. A third of humanity does not have access to commercial energy services while we are putting the primary resources into oversized cars for two-kilometre-trips and up the chimney of ill conceived homes. What are we waiting for ?