Energy & climate

Nuclear, short of power to solve energy and climate issues

1. The converging of risks in the short-term

In today's world facing a surge in prices of fossil energy products and fears of a climate upheaval in the short term, nuclear power seems to be moving up the political agenda once again. This comes after a 20-year period of global stagnation of which the French are generally unaware. Both in the EU institutions and at international level, the French Government is pressing for a strong revival of nuclear energy in countries which already implement the technology and for widespread access to nuclear energy for civil uses in countries which do not have it yet, particularly in the Mediterranean countries.

The main arguments put forward in support of this revival are climate change and energy security. **What are these two risks?**

The climate risk

The latest report by the Intergovernmental Panel on Climate Change (IPCC) shows the urgent need to take action to avoid the worst in terms of global warming. It first shows that if the global average temperatures in the atmosphere rise 2.5°C-3°C above pre-industrial levels, there is a strong risk that irreversible impacts, such as the melting of permafrost, a highly reduced role of forest cover and oceans as carbon sinks, will occur. These phenomena, in turn, can lead to unavoidable destabilisation of the climate. This is the reason why regions such as Europe have set a target which, if it became a multilateral commitment, would enable the global average temperature rise not to exceed 2°C.

Comparing the scenarios defined by climate experts shows that the only reasonable chance of statistically reaching the '2°C constraint' is if humanity manages to stabilise concentrations of all greenhouse gases (GHGs) between 400 and 450 parts per million by volume of CO_2 equivalent (ppmv CO_2eq) in the long term. However, the analysis also highlights that if GHG concentrations go significantly beyond this target threshold at any time in the intermediate period between 2020 and 2100 (above 475 to 500 ppmv), it is likely that it would become impossible to reach the target at all and that irreversible climate impacts would occur.

In 2005, atmospheric concentrations of CO_2 had already reached 379 ppmv and since the year 2000, global emissions of GHGs, as a whole, have been increasing at a rate of 3% per year and this upward trend shows no sign of reversing. Clearly, under these conditions, it is likely that the maximum acceptable concentration will be exceeded well before 2050.

Consequently, the climate question will arise in a far shorter term than policy-makers generally imagine. To avoid uncontrollable destabilisation of the earth's climate, a turning point needs to be reached in the extremely short term followed by a steep decline of around 40% of global emissions by 2030 (in t CO_2eq[1]) compared to 1990 levels.

[1] One t CO_2eq: tonne of CO_2 equivalent, a conventional common unit to measure the emissions of all greenhouse gases.

This implies that policies must be adopted and implemented to reduce emissions of GHGs, each of which has a different impact on the climate over time. These emission reductions have to target very different sectors.

Energy security

National and regional energy security is generally – and wrongly – limited to **security of energy supply**. Obviously, it also depends on several other parameters. In addition to vulnerability in relation to raw material imports, depending on the nature of the energy products (and the associated geopolitical conditions), economic sectors and energy efficiency in the different sectors, there are a series of parameters concerning the vulnerability of economies on a domestic level: vulnerability to natural phenomena (rainfall, wind patterns, floods and droughts, hurricanes, earthquakes, etc.) or technological accidents, disturbances caused by man (malevolent action, strikes, peak consumption phenomena, etc.). Again, analysis of energy security infers not only analysis by technology, product, energy carrier, economic sector and region, but also an analysis of the wide range of alternative solutions in the event of a crisis.

Energy security problems in Europe are thus not limited to questions of dependence on oil or gas even if the recent and extremely sharp rise in the cost of these raw materials and the fear of resource shortages has rightly been the focus of attention of the Governments, citizens and consumers.

Rapid and vigorous action

These energy security and climate change concerns are not new.

However, what is new is that the associated risks are today no longer recognised as long term risks, likely to occur towards the end of the century, but as short term risks arising before or around 2030. The scale of values of the solutions put forward to deal with these two crises primarily depends on their potential dynamics to penetrate in the next 20 to 30 years.[2]

Not only do economic and financial considerations lie at the heart of these questions of dynamics but also a whole series of issues concerning technical training, social and industrial organisation, spatial planning, as well as regional and world trade.

Nuclear energy in the face of these issues

It is thus against the backdrop of these issues that the potential revival of nuclear energy must be assessed. If not, there is a high risk, as has happened several times in the past, that we will harbour illusions and let ourselves in for numerous difficulties.

2. In 2006 where are we at?

Figure 1 shows the breakdown of world primary energy consumption in 2006 by energy source. It can be seen that the source ‘primary electricity’[3] accounts for 9% of total world consumption. Taking into account the internationally recognised coefficients of equivalence between TWh (electricity production) and Mtoe,[4] the share of nuclear energy in the primary energy balance is 6%. World electricity production reached 2,800 TWh in 2006. Nuclear energy accounted for 15% of this total, renewable energy for 23%, and fossil fuels the remaining 62% (Figure 2).

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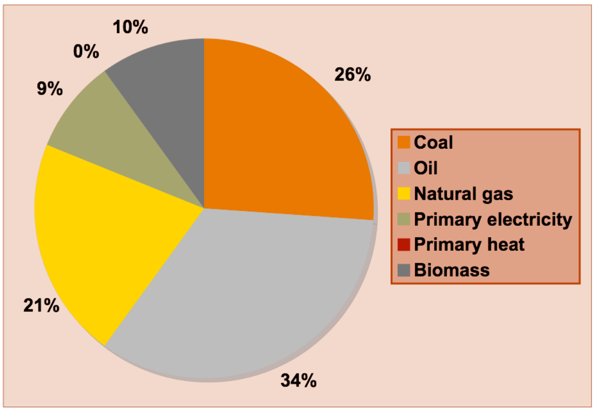
2 That is the reason why a series of technological step changes, such as controlled thermonuclear fusion, and even 4th generation reactors (which will not be commercially available until at best 2080 and 2040 respectively, according to their promoters) do not appear to be plausible solutions to the problem.

3 Mainly made up of nuclear- and hydro-generated electricity, but also wind and photovoltaics. World production of the latter two energy sources is still marginal.

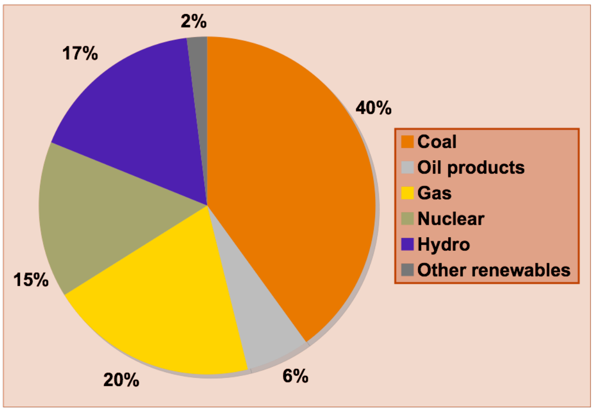
4 1 TWh of nuclear power = 0.21 Mtoe and 1 TWh of electricity produced from renewable sources = 0.086 Mtoe (TWh: TeraWatthour or billion kWh).

Figure 1 **World primary energy consumption by source (2006)**



Source: Enerdata

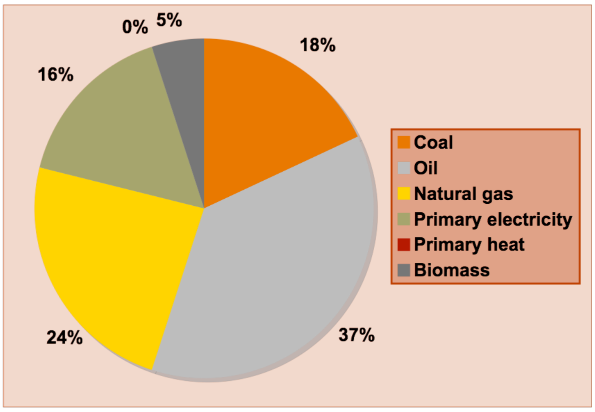
Figure 2 **World electricity production by source (2006)**



Source: Enerdata

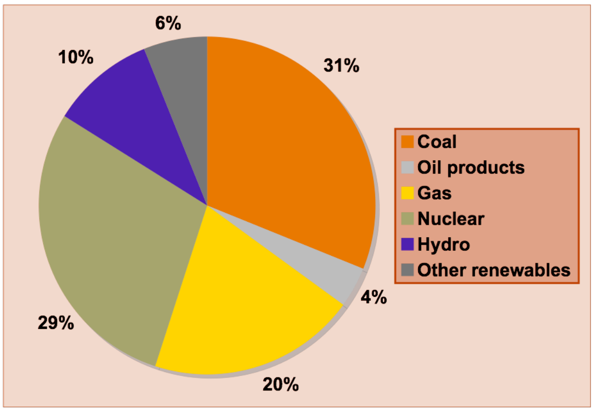
Primary electricity consumption in the 27 Member States of the European Union (EU-27) (Figure 3) accounted for 18% of its total primary energy consumption in 2006, ie double the share at global level. Nuclear power accounted for 13% of this primary balance. Nuclear generated electricity production in the EU-27 (Figure 4) accounted for 29% of total electricity production after coal (31%) and ahead of gas (20%) and renewable sources as a whole (16%).

Figure 3 **EU-27 primary energy consumption by source (2006)**



Source: Enerdata

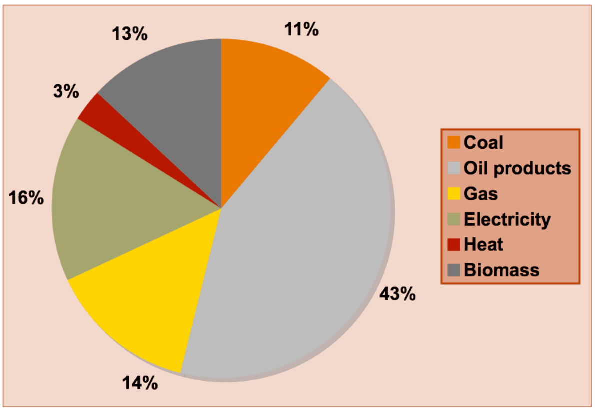
Figure 4 **EU-27 electricity production by source (2006)**



Source: Enerdata

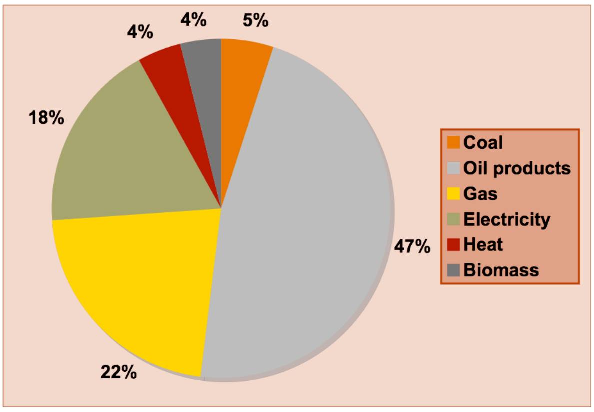
It is important to complete this general overview by an analysis of final energy consumption by energy source in the world and in the EU-27. This is the energy actually supplied to users after the conversion process: gas, electricity and heat to households, fuel for the tanks of heavy goods vehicles and cars, and for factories etc. (Figures 5 and 6).

Figure 5 **World final energy consumption by product (2006)**



Source: Enerdata

Figure 6 **EU-27 final energy consumption by product (2006)**



Source: Enerdata

Since electricity's share in the world final energy balance is 16% (Figure 5) and nuclear energy accounts for 15% of electricity production (Figure 2), it follows that the share of nuclear energy in world final energy consumption is 2.4%.

Similarly, as electricity's share in the EU-27's final energy balance is 18.3% (Figure 6) and nuclear energy accounts for 29.5% of electricity production (Figure 4), it follows that the share of nuclear energy in the EU-27's final energy consumption is 5%. Table 1 summarises these data:

Table 1 **Share of nuclear energy in energy consumption (2006)**

Share of nuclear energy in 2006 (in %)	In primary energy consumption	In electricity production	In final energy consumption
World	6%	15%	2.4%
EU-27	13%	29.5%	5%

Source: Enerdata

The share of nuclear energy in total electricity production varies enormously depending on the different countries. Three countries alone, the United States, France and Japan account for 56% of world nuclear-generated electricity production. France alone produces 45.5% of nuclear-generated electricity in the EU.

In France, and for year 2007, oil products represented 49% of total final energy consumption, far ahead of gas (21%), electricity (21%) and thermal renewable sources (6%). Final electricity consumption was 424 TWh, of which 24 TWh imported, 50 TWh from fossil fuelled power plants, 60 TWh from hydro power plants (and a small wind contribution) and 286 TWh from nuclear power plants. Which leads to a 67% contribution of nuclear in the final electricity consumption. Since the share of electricity in final energy consumption is 21%, the contribution of nuclear to the total final energy consumption of France is then 14%.

The claim that nuclear ensures the French energy independence is obviously farfetched. Table 2 shows the share of nuclear energy in national electricity production in the main countries which implement this energy technology. It highlights France's very specific situation in this field.

Table 2 **Share of nuclear energy in national electricity production (2005)**

Country	France	Ukraine	Sweden	South Korea	Japan	Germany	UK	USA	Russia	Canada	Rest of world
Share %	79	48	46	38	28	26	20	19	16	15	8

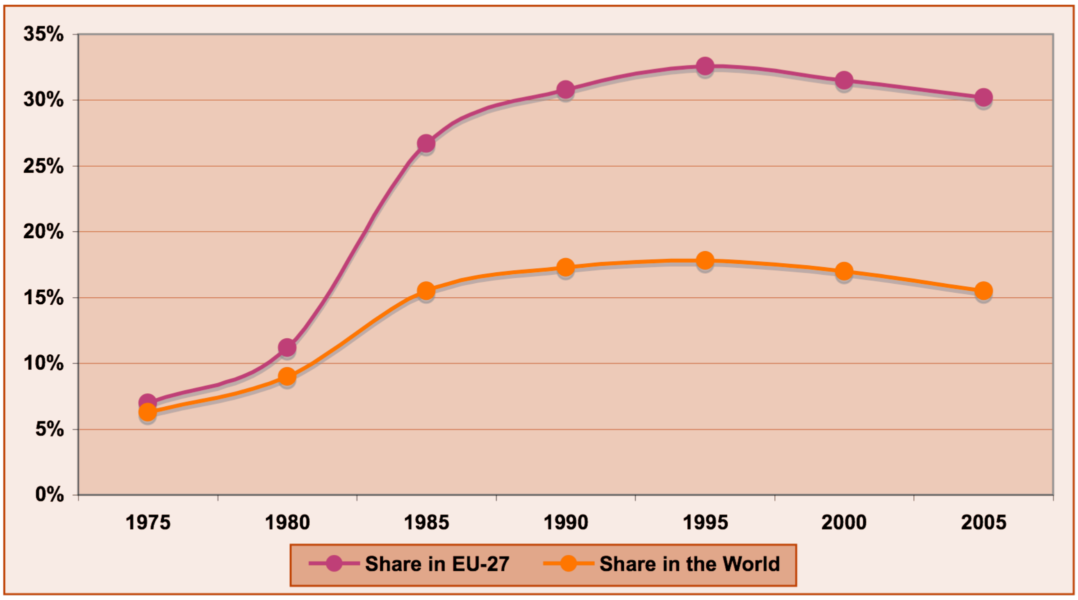
Source: IEA, *Key World Energy Statistics*, 2007

What has happened over the last two decades?

In the last 20 years, there has been a 40% increase in nuclear generated electricity production: 2,800 TWh in 2008 compared to 2,010 TWh in 1989. However, installed capacity, 371 GW in early 2008 (439 reactors) compared to 328 GW in 1989 (423 reactors), has only grown by 13%. This is a result both of orders for new build stagnating and an improvement in the use rate of existing plants.

During the same period (1989-early 2008), nuclear generated electricity production in the EU-27 rose from 775 to 999 TWh, ie +29%.This is less than the global increase (+40%). However, during the same period, world electricity production rose by 63% and that of the EU-27 by 33%. Changes over time in the share of nuclear generated electricity in world and EU electricity balances (Figure 7) logically show a peak around 1995 followed by a decline since then.

Figure 7 **Share of nuclear generated electricity in total electricity production in EU-27 and in the world (1975-2005)**



Source: Enerdata

Changes in capacity of the different sources of electricity production in recent years (Table 3) illustrate the reasons for this decline in the nuclear share which has been accentuated since the beginning of the 21st century. Worldwide, between 2000 and 2006, 18 times more gas generated electricity capacity was brought on stream than nuclear capacity, 13 times more coal generated electricity capacity, five times more hydro and even three times more wind.[5]

Table 3 **Increase in world installed capacity between 2000 and 2006, by source**

Source	Coal	Oil	Gas	Biomass	Nuclear	Hydro	Wind	Total
x1,000 MW	280	28	398	11	22	105	53	897
Share	31%	3%	44%	1.3%	2.4%	11.7%	6%	100%

Source: Enerdata

[5] The table indicates installed capacity. In terms of electricity generated, a fossil fuel-fired power plant or a nuclear power plant, with the same capacity, and operating on base load, will supply between 2 and 3 times more electricity than a wind turbine subjected to the intermittent character of the wind.

CO_2 emissions avoided in 2006

In order to assess the CO_2 emissions avoided by the different nuclear energy programmes at world, European and national levels, it can be assumed that if there were no such nuclear programmes, the electricity substituted would be produced by a range of sources similar to that which we see today minus nuclear power.[6] On this basis, global CO_2 emissions avoided in 2006 as a result of world nuclear programmes would be 1.8 Gtonnes of CO_2. This figure would be 0.43 Gtonnes for the EU-27.

These emissions avoided in 2006 would account for 3.6% of global GHG emissions (50 Gt CO_2eq) and 10% of GHG emissions in the EU-27. If this analysis is confined to CO_2 emitted by energy systems, it is estimated that the nuclear programme would account for a 6% reduction in emissions worldwide and for a 15% reduction in the EU-27.

However, if, as part of the fight against climate change, all currently operating nuclear power plants were replaced by modern gas turbine power plants,[7] this would require an additional consumption of 420 Mtoe of natural gas (+17%), which would lead to 1 Gtonne of CO_2 emissions. Europe would use an additional 135 Mtoe of natural gas (+30%) which would cause an additional 320 Mtonnes of CO_2 emissions. Table 4 summarises the various aforementioned data for 2006.

Table 4 **Nuclear energy's contribution to avoid GHG emissions in 2006**

Nuclear energy's contributions to:	World	EU-27
Reduction of CO_2 emissions from the energy system	6%* to 4%**	15% to 11%
Reduction of emissions of all GHGs (in CO_2eq)	3.6% to 2%	10% to 7%

* current configuration of electricity production
** natural gas combined cycle gas turbine power plants

Source: Global Chance

In realistic terms, this is what nuclear power represented in 2006 in terms of the fight against climate change. It is obviously not insignificant. However, it is important to bear in mind that the impact of current nuclear programmes on GHG emissions, even in Europe, remains minimal and has been decreasing each year since the 1990s.

Nuclear and greenhouse emission reduction in France. In 2005, the total emission of GHG in France is 553 Mt CO_2eq, of which 378 tonnes of CO_2.

To evaluate the contribution of nuclear to the CO_2 emission reduction, we compare the level of emission of the nuclear system with the emission of the natural gas combined cycle power plants which would deliver the same quantity of electricity to the final consumer (see above). Depending on the level of emission attributed to the nuclear system , the difference in emission level is 60 to 100 Mteq CO_2eq, that is 15 to 20% of the total greenhouse gas emission of France: it is far from negligible but 80% or 85% are remaining.

If nuclear electricity is replaced by renewable electricity, the gain on emission reduction is the same, or even superior (for wind energy for instance).

Energy security

The global consequences of nuclear programmes on the world's and the EU-27's supply have been indicated in terms of primary energy (respectively 6% and 13% using the coefficients of equivalence for electricity production) and of final energy (respectively 2.4% and 5%). This global analysis must be completed by an analysis by sector and by energy source. Thus:

- **Electricity:** It is well-suited to certain uses in the residential, tertiary and industrial sectors but almost impossible to use in some sectors, such as road, air and maritime transport. In practice, the

[6] The corresponding 'electric mix' is as follows: for the world, 21% renewable sources, 48% coal, 24% gas, 7% oil; and for Europe: 22.5% renewable sources, 44% coal, 28% gas, 5.5% oil.
[7] Combined cycle gas turbine power plants which reach a 58% energy efficiency.

specific features of nuclear generated electricity limit its uses to 'base load' operations (relatively stable use over a long period of the year).

- **Oil**: 68% of the consumption[8] of oil for energy purposes is due to transport at world and EU levels. The contribution of current nuclear programmes to the required substitution of oil is very small. Conversely, nuclear energy can be used as a substitute for oil in the industry sector, and more marginally, in the residential sector where electricity for heating may be supplied by oil-fired power stations (for back-up purposes) during peak consumption periods.
- **Coal:** This is where the contribution of world nuclear programmes is the greatest by replacing coal-fired electricity generation capacity which provides a similar service (base load or semi-base load power) and, via electric heating or specific electric processes, meeting industrial and residential sector needs. In the latter sector, electric heating is produced from coal during peak consumption periods.
- **Natural gas**: Current nuclear generated electricity in part replaces gas-fired electricity production capacity and, via electric heating, it replaces industrial and residential sector applications. In the latter sector, electric heating is produced from gas during peak consumption periods.

Table 5 illustrates these different points for selected European countries whose use of nuclear energy to produce electricity is highly heterogeneous.

Table 5 **Per capita consumption of fossil energy products and nuclear share in electricity production in selected European countries in 2007**

Consumption per capita (toe)	EU-27	Germany	France	Italy	UK
Oil	**1.32**	**1.36**	**1.46**	**1.31**	**1.33**
of which electricity production	*0.05*	*0.03*	*0.04*	*0.12*	*0.02*
Natural gas	0.88	0.95	0.62	1.17	1.35
of which electricity production	*0.28*	*0.22*	*0.09*	*0.47*	*0.45*
Coal	0.66	1.02	0.22	0.29	0.63
of which electricity production	*0.5*	*0.86*	*0.11*	*0.2*	*0.53*
Nuclear share	**28%**	**22%**	**77%**	**0%**	**16%**

Source: based on Enerdata

It can be seen from the table that a country like France which produces almost 80% of its electricity from nuclear energy consumes more oil per capita than the European average as well as Germany (22% share of nuclear generated electricity), the UK (20% share of nuclear generated electricity) and Italy (0% nuclear generated electricity).

It is thus obvious that nuclear power, contrary to widespread opinion, was not an effective answer to oil pressure in 2006. It is not the same for gas or coal, per capita consumption of which in France is lower than the European average (-25% for gas and -69% for coal). Finally, it should be noted that if all nuclear power plants were replaced in France by combined cycle gas turbine power plants in order to provide the same amount of electricity to the final consumer, this would require a consumption of 47 Mtoe of natural gas, or 34 Mtoe of natural gas plus 7.5 Mtoe of primary electricity produced from non thermal renewable sources (hydro, wind, solar PV). The per capita consumption of natural gas would increase by 0.6 to 0.8 toe,[9] but the primary energy consumption per capita would fall by 1.4 toe.[10] In these conditions, the quantity of natural gas 'replacing' nuclear would represent 16 to 20% of total primary energy consumption.

8 Excluding non-energy uses.

9 Fact Sheet n° 4 in "Petit mémento énergétique – Eléments pour un débat sur l'énergie en France", *Les Cahiers de Global Chance*, special issue n° 1, January 2003.

10 The reason for this difference is the poor thermodynamic efficiency of nuclear power plants (33% as opposed to 58% for combined cycle gas turbine power plants) and the energy consumption of the nuclear fuel cycle (in particular Eurodif, the uranium enrichment facility).

Other aspects of energy security

Centralising the means of production, exacerbated in the case of nuclear power,[11] makes a country highly vulnerable to the consequences of an electricity production or transport failure, particularly owing to the large size of the plants and sites. In the case of a high share of nuclear generated electricity in total electricity production (greater than 25 to 30%), and of course even higher in France (79%), possible generic breakdowns, which can affect a whole generation of power plants, are a further major source of vulnerability.

In addition to these different sources of domestic insecurity, there are intrinsic vulnerabilities associated with the nuclear industry: the supply of uranium, the risks of a major accident, environmental risks as a whole and risks of proliferation resulting from the nuclear fuel cycle. These problems will be dealt with specifically in the second part of the report.

In summary

The nuclear industry has been in relative decline over the last 10 years compared to other means of producing power and, more generally, energy. In 2006, its contribution to the world's final energy demand was less than 2.5%. Its contribution to the EU-27's final energy demand was 5%. This is obviously very low.

Nuclear energy enables between 2 to 3.6%[12] of GHG emissions to be avoided at global level, and between 7 to 11% at EU level. Worldwide, it prevents the use of an additional 420 Mtoe of natural gas and 550 Mtoe of coal (respectively 17% and 18% of current consumption).

Conversely, its effect on oil consumption remains altogether marginal.

Beside the specific risks that nuclear energy incurs (major accident, proliferation, waste), it creates particular vulnerabilities given its extremely centralised means of production.

3. The issues up to 2030

Is the currently planned, or rather proclaimed revival of nuclear power, both at global and EU levels, such that it will significantly change the order of things in the next 20 years with regard to energy security and climate change?

To assess the real issues, it is useful to take a closer look, in light of recent developments, at the SUNBURN world nuclear revival scenario[13] produced in 2005, the main assumptions of which are as follows:

- A universal solution, in the sense of refusing to exclude certain countries for ideological, political or economic reasons, etc.;
- Maintaining the national character of programmes that we know today until 2030;
- Base load operations (around 7,000 hours per year) to ensure sufficient profitability of the installations;
- A minimum threshold for annual electricity demand below which it cannot be envisaged, for supply security reasons, to bring new nuclear plant on stream. The minimum threshold proposed in the scenario is 4 GW. Combined with the assumption of base load production, this leads to an access threshold of around 60 TWh/year;[14]

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[11] Owing to the size of reactor units and the difficulties in finding sites (in France, 58 reactors located on some 20 sites which generated a net total of 419 TWh of electricity in 2007). The size of coal-fired power plant sites can however reach similar proportions to those of nuclear plants.

[12] Depending on the type of substitution envisaged.

[13] B. Dessus, Ph. Girard, "Le scénario SUNBURN de relance du nucléaire mondial", *Cahiers de Global Chance*, n° 21, March 2006.

[14] Basic needs account for about 50% of total annual needs.

- Contributions to base load production from other energy sources: hydro: 30%, wind: 20%, biomass: 60%, waste and geothermal: 100%;
- Lifetimes of the power production facilities ranging from 20 to 50 years depending on the technology used, construction times ranging from 1 year (wind) to 6 years (nuclear) and lead time to launch nuclear programmes ranging from 3 to 5 years for countries previously with no nuclear power.

Based on these assumptions and drawing on the 2004 'Business as usual' scenario published by the International Energy Agency (IEA),[15] the SUNBURN scenario estimates, by country or geographical region, year on year, basic power needs, existing capacity on stream and its contribution to base load power production, renewable energy capacity installed and its contribution to base load power production, and lastly, the remaining needs likely to be met by nuclear energy. A more or less large share of this remaining need is thus met by nuclear energy, given the initial lead times for starting nuclear programmes and industrial dynamics.

Based on these assumptions, there would of course be an extremely rapid development of world nuclear power from 2015 onwards. Under these conditions, new capacity coming on stream, around 3 GW per year on average between 2000 and 2005, would reach some 20 GW by 2015, 40 GW by 2020, 75 GW by 2025 and over 100 GW by 2030 (ie the equivalent of the current capacity of the US nuclear reactors on stream), this means a world market multiplied by 50 in 25 years. Nuclear capacity would amount to 1,200 GW in 2030, generating almost 9,000 TW of power per year. Some 30 new countries (8 in Europe,[16] 4 in South Amercia , 5 in Africa, 5 in the Middle East and 7 in Asia) would have nuclear power. The EU-27 would generate 1,400 TWh in 2030. Despite the abundance of cheap local coal resources, China, India and South Korea alone would generate almost 1,400 TWh in 2030.

However, even in circumstances so obviously propitious to nuclear energy, the consequences on CO_2 emissions and fossil fuel reserves would remain relatively insignificant. Comparing this with IEA's scenario, in which nuclear capacity is maintained at current levels, sheds an interesting light on the matter:

If it were fully implemented, the SUNBURN scenario would enable 9% of total CO_2 emissions from energy to be avoided in 2030 compared to IEA's forecast scenario (5 to 6% of GHGs as a whole in 2030), but only 2.9% of cumulative emissions from 2006 to 2030 in this same scenario, ie seven times fewer emissions in 2030. Furthermore, it would enable a 15% saving of fossil fuel-generated energy in 2030 but only a 5% saving of the cumulative fossil fuel-generated energy used between now and 2030, mainly coal and natural gas. It would prove to be widely ineffective for oil.

In Europe, this revival would enable a 200 Mtoe saving of natural gas (30%) in 2030 and 480 Mtonnes of avoided CO_2 emissions compared to a total phase-out of nuclear power in 2030.

When all is said and done, this situation is quite similar to the one we experienced in 2006.

The authors of the SUNBURN scenario strongly emphasised the many vital issues to be resolved:

- The financial question, with an annual investment of € 50 billion per year on average from 2015 to 2030, on the basis of an estimated cost, at the time, of € 1500/kW (with an exchange rate of €1 = $1.20);
- The question of a need for a skilled workforce requiring 500 000 technicians to be trained before 2030 for production facilities and control authorities yet to be created;
- The question of industrial capacity, both to build the power plants and to set up the fuel cycle, or to open new uranium mines;
- The question of governance, with the need for major investments in human resources and organisation on the part of countries wishing to adopt a nuclear energy programme in the next 10 to 15 years, but also the need to define and adopt international rules applicable to all

[15] *World Energy Outlook 2004*.
[16] Including Portugal, Italy, Poland, Greece, Austria and Denmark.

countries concerned (transport of raw materials and waste, measures to protect against the risk of proliferation, safety and security of nuclear installations, etc.). In connection with this, a recent memorandum issued by the French Nuclear Safety Authority (ASN) insists on this issue in unequivocal terms, with a subheading as follows: “Let's be clear. Learning nuclear safety is a long process.”[17]

Not to mention of course the specific risks that this nuclear revival would incur (risks of major accidents, proliferation, waste) due to the increased number of installations, their rapid geographical spread and the irreversible nature of the technological solutions that such a scenario would entail by imposing the success of the challenge of widespread use of nuclear power in most countries of the world, relying on large-scale use of plutonium, which will have become essential for the sake of making the resource last.

Three years on, where are we at, beyond the declarations, in relation to this vision? First of all, it should be noted that in 2007 nuclear power production continued its decline (-2% compared to 2006) and that no large-scale programme has been launched since 2005. Construction of the only two planned reactors in Europe, the Finnish and the French EPRs (admittedly, with the exception of the two Bulgarian reactors Belene 1 and 2 officially under construction since 1987) has been beset with difficulties and significant delays (at least two years for the Finnish EPR).

It can also be seen that there has been a surge in nuclear power investment costs in dollars since 2000,[18] +170%, a far greater increase than for wind power investment costs (+110%) and particularly for coal-fired power plants (80%) and gas-fired power plants (90%). In these conditions, it is highly unlikely that the major Asian countries and the United States which have significant and cheap coal resources will give up using this energy source for base load power production and take up nuclear energy on a large scale.

Similarly, the lack of investment in research and production of uranium over the last 10 years has led to tension in uranium prices which have increased tenfold on the spot market since 2002. Although spot market prices went back down to half that peak by mid-2008, the odds are that some tension will continue and even increase since lead times for the opening of new mines keep getting longer. Lastly, since 2005, political tensions both in North Korea and Iran surrounding the nuclear issue have heightened the international community’s mistrust of a certain number of countries gaining access to nuclear energy, even if it is for non-military uses.

In light of these developments and despite the optimistic attitude of nuclear energy proponents, it appears clear that achieving such a scenario, which in 2005 was already considered particularly optimistic, is more and more unlikely (even with an additional 4 to 5 years’ lead time, which would have serious consequences in 2030).[19]

More recently, for no clear reason, the IEA cast aside its usually reserved stance on world nuclear growth capacities in 2030.[20] On behalf of the G8, it produced a much more pro-nuclear energy scenario.[21] It is based on the relatively simplistic assumption of a growth rate of nuclear energy in relation to world GDP similar to that which it showed during its most prosperous period. On this basis, the “bluemap” scenario, the most pro-nuclear one, drawing on plans for strong potential development as stated by China, Russia, South Africa, the United States, Ukraine and India, and estimating future nuclear energy investment costs at around $ 2,500/kW, projects that world nuclear power production will amount to about 6,000 TWh in 2030 and 9,000 TWh in 2050. But, unlike the SUNBURN scenario, this industrial-type analysis avoids any description of regional needs and constraints, does not address

[17] The position of the French Nuclear Safety Authority (ASN): "Safety of the new plans to build nuclear reactors in the world must be ensured", 16 June 2008.

[18] Cambridge Energy Research Associates, *Construction Costs for New Power Plants Continue to Escalate*: IHS CERA Power Capital Costs Index.

[19] A five-year delay would cause a 30% fall in projected nuclear power production in 2030.

[20] In the Outlook 2004 and 2006 scenarios, nuclear energy growth stagnated or was slow (2 GW per year in *Outlook 2006*).

[21] *Energy Technology Perspectives 2008, Scenarios and Strategies to 2050*, AIE.

the issue of uranium resources and seems highly optimistic regarding investment costs in relation to the reality of today.[22]

Let us nevertheless imagine that it can be implemented in the timeframe envisaged. According to the IEA itself, it would enable 5% of CO_2 emissions from the energy system in 2050 to be avoided (around 3.5% of GHGs as a whole).[23] Not only is this a very small amount in absolute terms but also in comparison with other options put forward by the same study and in particular the saving of electricity generation, estimated alone to be more than double (10%) and incurring far lower costs.

Beyond the issues of political and economic credibility that they give rise to, all the studies focusing on a large-scale revival of nuclear power thus show the marginal nature of the results that can be expected in the medium term (2030) from the point of view both of energy security and climate change.

To say the least, it is far from having being proved that large-scale use of nuclear energy to address the main challenges facing humanity in 2030, climate change and energy security, is vital. In any event, nuclear power's contribution to solving these questions will be marginal.

On balance, on the basis of this marginality, deliberately omitted from the views aired by nuclear proponents, an analysis must be conducted of all the major political, economic, environmental and social problems that a large-scale revival of nuclear energy at EU and world level, as proposed today by the French Presidency of the EU, would give rise to.

[22] These costs are under-estimated by 30 to 40% compared to the estimated costs of the Finnish EPR reactor.

[23] To the point where it is questionable whether the IEA did not deliberately produce this optimistic scenario to emphasise the ineffectiveness and lack of interest compared with other GHG emission reduction options.