

5th International Seminar on Security and Defence in the Mediterranean

Multi-Dimensional Security

Energy and non-proliferation: An old or new Challenge?

Energy and non-proliferation.
Jorge Segrelles

Jorge Segrelles

Repsol YPF Foundation, Managing Director

The increasing concern in the economies of the developed countries about energy dependence, the security of supplies, forecasts about the exhaustion of fossil fuels, their rising prices, and the incessant increase in CO₂ emissions at the world level, have led to the appearance of different proposals in the European Union (EU) and the United States. These proposals share a bet for energy efficiency, research and development of clean, renewable energies and the use of nuclear energy, although the EU leaves it up to its member countries to choose their mixtures of energy sources.

The latest International Energy Agency studies (IEA, *World Energy Outlook*, 2006) foresee a world-wide growth in installed nuclear power for the year 2030 from 368 GW (gigawatts) in 2005 to 416 GW in the reference scenario, or up to 519 GW in an alternative energy policy scenario. According to the IEA, in an optimistic scenario of technological progress, electricity generated from nuclear power in the year 2050 would double that of today. Nuclear waste management and the possible proliferation of nuclear weapons are the main obstacles, while nuclear fusion will not be viable before 2050 in the most optimistic scenarios.

The international debate on nuclear energy is open. In some EU countries, the possibility of a change in energy policies is being considered. For example, Spain inaugurated a "Table of Dialogue" and in the United States, the "Global Nuclear Energy Partnership" was launched. A bolstering of the authority of the International Atomic Energy Agency (IAEA) is requested. Meanwhile, countries like North Korea and Iran may come to increase the number of countries with nuclear weapons, and recently, six Arab countries have shown their intention to construct nuclear powerplants for civilian uses.

The expansion of the peaceful use of nuclear energy is inevitable and it is necessary to direct efforts toward agreements and pacts that guarantee this peaceful use.

The energy future

In the last few years, with the increase in the price of crude oil, geopolitical tensions and heightened awareness of the effect of CO₂ on climate change, the developed economies have shown a growing concern for sustainability and security in the supply for their energy systems.

The predictions of a fast decline in oil reserves, with their depletion forecast for the next decade according to Hubbert's "peak oil" theories (called into question at present by discoveries in the Gulf of Mexico), the concern about the delay in the called-for reductions of greenhouse gas emissions with their foreseeable effect on climate change and the growing energy dependence for oil supplies on third countries with unstable political situations, such as some in Latin America and the Middle East, were the motor of the revising of energy policies. This revision began simultaneously with the United States Energy Law and Bush's "Advanced Energy Initiative", and the launch of the "Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy" in the European Union.

Both strategies share common features:

- Efficiency in energy use.
- The use of renewable wind, solar or biofuel energies.
- Provision of incentives for research to develop clean technologies (without CO₂ emissions).
- The use of nuclear energy. Whereas the United States place their stakes on the use of this energy, with clear proposals like the GNEP (*Global Nuclear Energy Partnership*), the EU limits itself to recommending a debate on nuclear energy, leaving it up to each state to choose its energy mix, bearing in mind the criteria of sustainability and the security of supply.

Within this context, the International Energy Agency has recently published its annual study on the long-term forecasts of the energy sector (*World Energy Outlook*, 2006). It presents two scenarios, a Reference Scenario, with no change in energy policies, and an Alternative Policy Scenario, with the implementation of policies that stimulate energy efficiency, the reduction of CO₂ emissions and the security of supplies.

In the reference scenario, world-wide demand for primary energy grows by over 50% between 2004 and 2030. All types of energy increase, but the one that does so the most in absolute terms is coal. Consequently, CO₂ emissions fundamentally rise by 55% in this period, due, fundamentally, to new electricity-generating projects using coal in India and China. The installed power of nuclear electricity generation grows only by 13%, from 368 GW to 416 GW. In this scenario, oil and gas supply security is threatened, due to diminishing production in Organisation for Economic Co-operation and Development (OECD) countries. The increases in demand for oil must be covered through greater production on the part of the Organization of Petroleum

Exporting Countries (OPEC), while those for gas must be met by Russia and countries in Latin America, Africa and the Middle East. CO₂ emissions cannot be reduced, either.

The alternative scenario contemplates a series of energy policies, among which we summarize the most important ones in terms of their effect on world-wide energy consumption:

- Energy efficiency: Improved mileage in vehicles in the OECD countries, increased energy efficiency in the residential and commercial sectors in the OECD countries and China and improved efficiency in coal-burning electricity plants in China.
- Increase in the use of renewable energies in general.
- Lengthening of the useful lives of nuclear plants in the EU and the United States and a greater weight for nuclear energy in China and India.

With the implementation of these policies, the alternative scenario yields a primary energy consumption in 2030 which is 10% lower than in the reference scenario. Fossil fuels go from making up 81% of the total demand in the reference scenario to comprising 77%, which is still a very significant figure. The greatest decreases with respect to the reference scenario occur with coal, followed by oil and gas, in this order. The greatest increase between both scenarios, in absolute values, occurs with nuclear energy, which rises from 416 GW to 519 GW. The relative weight of this type of energy is 7% of the total demand. Renewable energies provide 16%. CO₂ emissions are reduced by 16% with regard to the reference scenario; 78% of this decrease is due to efficiency measures, 12% to the greater use of renewable energies and 10% to the greater weight of nuclear energy.

This year, the International Energy Agency also prepared a study on the prospects of energy technology for 2050 in response to a request from the G-8. In the most optimistic scenario regarding technological advances, fossil fuels will be 58% of the total in 2050, with a reduction in the use of coal and oil and an increase in gas; nuclear energy will represent 12% of the demand and renewable energies will make up 30%. The installed capacity for nuclear energy will double that of the present day, which in reality means a renovation of the pool of nuclear plants with more efficient Generation III+ and Generation IV powerplants.

Nuclear energy

Doubts about the security of supplies, prices of fossil fuels and the impossibility of reducing CO₂ emissions have again put the discussion of the role that nuclear energy must play in the energy mix on the table. As we have seen, energy efficiency and renewable energies will play an increasingly important role. Nuclear energy also will have a growing role, but not all countries contemplate this type of energy in the same way, since often social rejection (safety issues, nuclear wastes, proliferation) is greater than the technical and economic advantages.

The main advantages of nuclear energy are:

- The non-emission of CO₂ or other air pollutants, such as SO₂, NO_x or aerosols.
- Reduction in dependence on gas importation. There are sufficient uranium reserves distributed throughout the world.
- Stability in production costs, since the cost of fuel represents only 15% of the total, including its treatment.

As disadvantages we can mention:

- High cost of investment and long maturation periods for a project (between ten and fifteen years).
- Social rejection over the safety of the location (increased by the possibility of terrorist acts) and over the handling of nuclear waste.
- International concern about proliferation.

In 2005, there were a total of 443 installed nuclear reactors for electrical production. Of these, 351 are located in the OECD (the United States, France, Japan, the United Kingdom, Korea, Canada and Germany are the countries with the most installed capacity: 297 reactors altogether), 54 in transition economies (Russia, Ukraine and other countries of the old Commonwealth of Independent States - CIS-) and 38 in developing countries (mainly China and India). In addition, there are 284 research reactors in 56 countries and 220 reactors running military vessels. At present, of all the electrical energy generated in the world, 15% is of nuclear origin, accounting for 368 GW, but there is a great difference among countries. Thus, in the European Union, 31% of the electricity is produced by nuclear powerplants, but with enormous differences (79% in France, 26% in Germany, 20% in Spain, and 4% in the Netherlands, while countries like Austria, Denmark and Ireland prohibit the use of nuclear energy to generate electricity). In emerging countries like China, India and Brazil, only a little over 2% of the electrical energy is produced by nuclear powerplants.

Only five countries within the OECD have taken measures to construct new plants: Finland, France, Japan, the Republic of Korea and the United States. Seven countries have legal restrictions on the construction of new plants: Germany, Australia, Austria, Belgium, Denmark, Ireland and Sweden. The rest of the countries have yet not defined a concrete plan or are discussing the role of nuclear energy, such as Spain, which recently hosted a "Table of Dialogue on the Evolution of Nuclear Energy in Spain", which proposes a two- or three-year debate to define a sustainable matrix of primary energy with a time horizon of the period between the years 2020 and 2030, maintaining, however, the anticipated plan to close powerplants.

Nuclear technology and proliferation

Without getting into excessively technical details, we can divide the present nuclear fission reactors into three categories:

- Open, once-through, thermal reactors, which use enriched uranium, with the spent fuel being disposed of (these comprise the majority of

existing powerplants).

- Thermal reactors with reprocessing using a closed fuel cycle, in which plutonium is separated from the irradiated fuel by means of a process called PUREX/MOX. The fuel not used by the reactor is recycled, and the other products from fission that are not used are disposed of.
- Fast reactors, which use uranium and plutonium oxides as fuel.

The so-called Generation IV reactors presently being developed are variants of those types of reactors in which new possibilities of cooling the reactors through liquid metal, gas, water at supercritical pressure and higher operating temperatures due to new materials are being developed. All of this leads to greater efficiency (and less waste material). They will be available beginning in 2030.

The nuclear fuel cycle, which goes from the enrichment of uranium ore to its recycling and later treatment and the storage of radioactive waste, has a great importance from the point of view of the risk of proliferation. The reprocessing of fuel with the separation of plutonium PUREX/MOX, currently used in Europe and Japan, represents the greatest risk of nuclear proliferation. At present, there may be 250 tons of separated plutonium world-wide (8 kilograms of plutonium or 25 kg of uranium is sufficient to make a bomb according to the IAEA).

According to an interdisciplinary Massachusetts Institute of Technology (MIT) study on the "The Future of Nuclear Power", one way to prevent the accumulation of plutonium as waste from used fuel would be a balanced combination of open thermal reactors, distributed world-wide, and a balanced number of fast reactors located in safe nuclear parks in industrialized countries, which would reprocess the fuel used by thermal reactors and eliminate the separated plutonium. The GNEP (*Global Nuclear Energy Partnership*) proposal of the United States goes in this direction. There would be fuel providers operating advanced nuclear plants and fuel-cycle facilities, minimising waste, and there would be nuclear fuel users, those who operate reactors, and they would receive the fuel, use it and return it to the supplier for reprocessing and final storage. In this way, the use of nuclear energy could be expanded without increasing the risk of proliferation.

The GIF (Generation IV International Forum), comprised of ten countries, has the objective of developing the technology of the future nuclear powerplants, the so-called Generation IV ones, which will be available from 2030 on. One of the objectives of the Generation IV group is for its systems to be "proliferation-resistant", that is, for them to not be very attractive and to offer the least desirable path possible for obtaining materials that could be used in nuclear weapons.

Fusion reactors, the development of which is not expected before 2050, would be the clean answer to nuclear energy, without waste or risk of nuclear proliferation. The ITER program for the construction of an experimental fusion reactor in France will take ten years to build and will need 25 years of operating time before an industrial prototype can be constructed. Therefore, this technology will not be available until the second half of the 21st century.

Beyond technology

Although it is true that the expansion of nuclear energy for civilian uses could increase the risk of proliferation, at present, technological barriers do not exist for making experimental reactors and facilities that would allow for the enrichment of uranium. On the other hand, the Nuclear Non-Proliferation Treaty (NPT) recognizes the right of any signatory country to investigate, produce and use nuclear energy for peaceful purposes. The Safeguard Agreements between the IAEA and the signatory countries of the Nuclear Non-Proliferation Treaty are not always enough to guarantee the peaceful use of nuclear energy. In the case of Iran, as Mohammed El Baradei showed in November 2006 in the meeting of the Board of Governors of the IAEA in Vienna, the Agency needs transparency measures that go beyond the legal requirements in the Safeguard Agreement to ensure the peaceful nature of the nuclear activity of Iran.

In addition, according to the IAEA, six Arab countries (Algeria, Saudi Arabia, Egypt, the United Arab Emirates and Tunisia) have recently shown their intention to construct nuclear powerplants to generate electrical energy for desalination plants. According to experts on proliferation, this announcement, in some way, is a consequence of Iran's position. Already in their book, "Getting Ready for a Nuclear-Ready Iran", published by the Institute of Strategic Studies of the United States Army, Henry Sokolski and Patrick Clawson anticipated the possibility that neighbouring countries like Saudi Arabia, Egypt and Algeria, would follow Iran's example. If Iran obtained nuclear weapons at some point in time, it could trigger a nuclear arms race in North Africa and the Arabian Peninsula.

It will be necessary to strengthen the role of the IAEA to supervise this expansion of nuclear energy and watch over compliance with the Non-Proliferation Treaty. New tools, like the treaty to prohibit the manufacturing of nuclear fuel (FMCT), under negotiation for a long time, would be useful in preventing proliferation. In addition, a great diplomatic effort will also be necessary for implementing initiatives such as the GNEP, which, in some way, limit the competencies of the user countries in the face of the supplying countries.

We can conclude that the expansion of the use of nuclear energy for peaceful purposes is inevitable and necessary, especially in developing countries, and we must direct efforts toward reaching agreements and pacts that guarantee that the technologies available now and in the coming decades be used in an appropriate way.

Bibliographical References

DEUTCH, John and MONIZ, Ernest, *The Future of Nuclear Power*, Interdisciplinary Study by the Massachusetts Institute of Technology (MIT), Cambridge MA, 2003.

EUROPEAN COMMISSION, "A European Strategy for Sustainable, Competitive and Secure Energy", Green Paper, March 2006.

GNEP U.S. DOE 2006, *The Global Nuclear Energy Partnership (GNEP) Presentation*, Available from: <http://www.gnep.energy.gov>

OECD/INTERNATIONAL ENERGY AGENCY, *World Energy Outlook 2006*.

OECD/INTERNATIONAL ENERGY AGENCY, *Energy Technology Perspectives 2006, in Support of the G8 Plan of Action*.

"Quantifying energy". BP Statistical Review of World Energy, June 2006.

SOKOLSKI, Henry and CLAWSON, Patrick, *Getting Ready for a Nuclear-Ready Iran*, Strategic Studies Institute of the U.S. Army, 2005.

U.S. D.O.E. and GIF, *A Technology Roadmap for Generation IV Nuclear Energy Systems*, December 2002.

WHITE HOUSE NATIONAL ECONOMIC COUNCIL, *Advanced Energy Initiative*, February 2006.