International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13)

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Opening Session

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Good morning, Ladies and Gentlemen.

As a representative of the French Ministry of Ecology, Sustainable Development and Energy, I am honored to deliver an opening address to the 2013 International Conference on Fast Reactors and Related Fuel Cycles (FR13), organized by the International Atomic Energy Agency (IAEA) and hosted by the Government of France through CEA (the French Alternative Energies and Atomic Energy Commission) and the French Nuclear Energy Society (SFEN).

First of all, I would like to express my appreciation that so many participants, both from home and abroad, are attending this conference. I'm also most grateful for the commitment that the International Advisory Committee, the International Scientific Programme Committee, the Local Organizational Committee and the Local Executive Committee members have shown in holding this year's conference, FR13. For this conference, about 600 participants have registered from various countries and three international organizations (the European Commission, OECD Nuclear Energy Agency, and the International Atomic Energy Agency). I am very impressed by the quality of the numerous papers submitted to this conference.

For this opening address, I would like to share with you some thoughts about the evolution of the key drivers during the last decades for the development of fast reactors from the very pioneering age till now, taking into account new concerns and major events occurred since the last international conference on fast reactors and related fuel cycles held in Kyoto, Japan (FR 2009).

There are three major periods:

- The pioneering age (1945-1980) with breeding as a main driver followed by a kind of "winter season" (1980-2000) for the development of fast reactors worldwide;

- The so-called "brainstorming" phase (2000-2010), back to physics and nuclear chemistry, with international rebirth of the research on fast reactors and advanced fuel cycle owing to the GENERATION IV initiative, revisiting various reactor concepts along with 4 main drivers: sustainability, safety, proliferation resistance and cost-competitiveness.

- A new era now (started in 2010) with very promising technological options and projects of prototypes with two main key drivers:

  - Innovation towards enhanced safety which is a major concern for public acceptance of nuclear power, especially after the FUKUSHIMA accident.
  - Higher flexibility in the management of fissile materials and nuclear waste in order to take into account various possible options for the contribution of nuclear power in the energy mix.

Let me briefly elaborate on these three periods.

<u>The pioneering age</u>

As you may know, the story started with some brilliant intuitions of talented physicists. Among them, one can mention Enrico Fermi who stated in 1945 " *The country which first develops a breeder reactor will have a great competitive advantage in atomic energy."*

Based on this principle, nearly 62 years ago on 20 December 1951, the Experimental Breeder Reactor (EBR-I) provided the first useful electricity from nuclear energy, powering four light bulbs in the Idaho desert. This provided the first evidence of the enormous potential for fast reactor technology to satisfy future energy needs. In the following two decades, several countries followed the US in launching an intensive fast reactor program. Plutonium-fueled breeder reactors appeared to offer a way to avoid a potential shortage of the low-cost uranium required to support such an ambitious vision using other kinds of reactors.

As you know, the development of fast reactors worldwide was however not so quick mainly for three reasons. First reason, proliferation concern emerged in the seventies when the Ford and Carter Administrations decided to oppose further export of reprocessing technology. The 1978 Nuclear Nonproliferation Act (NNPA) sought to tighten the criteria for nuclear cooperation and reshape the nuclear fuel cycle. Second reason, Uranium proved to be much more abundant than originally imagined and, after a fast start, nuclear power growth was slower than projected in the early 1970s. It was also due to the fact that the demand for nuclear energy declined after the Three Mile Island and Chernobyl accidents, as well as from the belief that fossil energy was plentiful and would remain cheap. Third reason, because of the high costs, reliability and safety issues, no commercial breeder reactors have been deployed.

It took about 20 years to realize that nuclear energy could expand again, owing to the energy and climate challenges the world was faced with, and with that, the potential use of fast reactors became possible in order to account for the constraints of such expansion.

The so-called “brainstorming” phase (2000-2010) towards the rebirth of fast reactors owing to the GENERATION IV international initiative

In 2000, the context was quite different and the development of fast reactors had to be made on a new basis, taking into account new drivers such as cost-issues, safety and reliability, sustainability (resource saving and waste minimization) and physical protection against terrorism or proliferation.

Such huge technological challenges also require that the new fast reactor designs be developed internationally, within multinational cooperation frameworks. Such is the goal of the Generation IV International Forum (GIF), which is a gathering of the major key actors in the field of R&D, cooperating for the sustainable development of nuclear energy. A new way of thinking has emerged from this new context: the awareness that a global solution is required, accounting not only for fast reactors and their associated fuel recycling, but also for full burning of actinides created in both light water reactors and fast reactors.

As far as I know, a variety of fast reactors can be considered for transmutation. The fundamentals of fast reactors were therefore revisited using different coolants (sodium, lead or gas), and much effort were also devoted to study the feasibility of various advanced fuel cycle options to separate and burn some of the minor actinides such as Neptunium, Americium, or Curium.

This GENERATION IV program had led to various incentives worldwide to study the feasibility of technological demonstrators of advanced fast reactors. I suggest having a look to the program launched in Europe. A new era with very promising technological options and projects of technological demonstrators: the case of Europe and the example of France.

As you may know, the European Council committed in March 2007 to very ambitious goals putting Europe at the forefront of the fight against climate change, and launching the "Strategic Energy Technology (SET) Plan" which identifies a list of competitive low carbon energy technologies to be developed and deployed in Europe. Nuclear power was of course included in this list.

In that respect, the European Sustainable Nuclear Industrial Initiative (ESNII) was officially launched in November 2010 under the SET Plan. Along with GENERATION IV key objectives, ESNII promotes advanced fast reactors with the objective of enhanced safety, resource preservation and minimisation of the burden of radioactive waste for a more sustainable development of nuclear energy.

The main objective of ESNII is to maintain European leadership in fast spectrum reactor technologies.

With respect to the 2010 evaluation of technologies, sodium is still considered to be the reference technology since it has more substantial technological and reactor operations feed-back.

The Lead(-bismuth) Fast Reactor technology has significantly extended its technological base and can be considered as the shorter-term alternative technology, whereas the Gas Fast Reactor technology has to be considered as a longer-term alternative option. Therefore, ESNII is aiming at promoting a consistent programme based on two main European projects, the Advanced Sodium Technological Reactor for Industrial Demonstration (ASTRID, French project) and the flexible fast spectrum irradiation facility MYRRHA (Belgium project). At this stage of my talk, I would like to focus a little bit about the R&D undertaken if France about fast systems and related fuel cycle.

Research activities in this field are implemented according to two French Parliamentary Acts, i.e. the 13 July 2005 Act specifying the energy policy guidelines and the June 2006 Act outlining policies for the sustainable management of radioactive materials and waste. In the latter act, a major milestone was defined for the end of 2012 and a status report was sent to French authorities reviewing the main results obtained since 2006. This very valuable work is of major interest at a moment where we have just launched a new national public debate about the future of our energy policy. This report has pointed out some key issues that I would like to share with you.

First issue is of course public acceptance of nuclear power especially after the FUKUSHIMA accident, requiring higher safety standards and technological innovations. In that respect, this report is reflecting major achievements to overcome by design some weaknesses of past generations of sodium-fast reactors, improving the natural behaviour of the core (core with negative sodium void coefficient), taking into account severe accident at the design stage to implement mitigation strategies (core catcher), investigating innovative power conversion systems to avoid (or to minimize the risks associated with) sodium reactions with air or water. The second issue is dealing with the sustainable management of fissile materials and nuclear waste. Whatever is the energy mix we will choose, we will have to deal with the plutonium built-up in PWR spent fuels and with the management of the long-lived radioactive waste. In that respect, fast reactors and associated closed fuel options have demonstrated very flexible features.

In summary, we know now that the initial Fermi intuition is confirmed. Promising innovation routes are now clearly identified to further enhance safety, reduce capital cost and improve efficiency, reliability and operability, making the Generation IV Sodium Fast Reactor concept an attractive option for electricity production. We thus rely on you scientists to demonstrate that these innovations are robust and to convince our stakeholders to go further. Such a conference is a very unique opportunity to discuss significant issues on fast reactor development and related fuel cycle development.

I sincerely wish that this conference will lead to a fruitful debate and that international cooperation dealing with research and development on fast reactors will be further strengthened.

Thank you very much for your attention.