REPORT SUMMARY

FUTURE OF THE FRENCH CIVILIAN NUCLEAR INDUSTRY

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INTRODUCTION

The actors of the French nuclear industry (EDF, Areva, Alstom primarily) are undisputed industry leaders in France where they gained their initial experience: they are now among the world leaders in their field and can rely on hundreds of small and medium French businesses. With 58 nuclear units in operation, the French nuclear park stands out as an exceptional technological and industrial success at a time when the market for nuclear plants is expected to profoundly change.

In fact, we are experiencing, worldwide, a strong increase for nuclear energy demand.
This "renaissance", which will likely result in about 250 new construction sites 20 years from now creates an opportunity as well as a challenge for France.

The French nuclear industry will indeed face a double challenge for 2030.

On a national level, the construction of a few new plants will need to be undertaken, the smooth operation of the park will need to be ensured and the preparation to extend the existing plants lifetime beyond 40 years will have to be done.

At the same time, the scheduled decommissioning of some facilities will have to be managed as well as the implementation of the program concerning nuclear wastes

On the internationally level, the task is new and even harder; a significant share of the market, highly segmented and competitive, for new nuclear plants will have to be captured,

The French nuclear industry must therefore adapt to be able to achieve this dual objective. This adaptation concerns the government as much as the sector enterprises. The government will have to continue playing a central role in the organization of the French nuclear industry, as all governments in the world do with the nuclear industry. The sector enterprises have, for their part, taken this international path a while ago. But by doing so, several weaknesses have emerged: problems with the global organization of the “Team France”, the competition for the offer, the financing capacity, the availability of human resources, the mobilization of R & D, etc.

The sector enterprises have to make considerable efforts to improve their offer in view of the existence of other industry giants.

They have the ability, provided convincing answers are provided regarding issue of nuclear financing and regarding the model of strategic alliances to put in place, to ensure the performance of the "Team France" for export.

These are some of the key issues facing French the nuclear industry that this report aims to answer.

I - the French nuclear industry

With nearly 200,000 direct and indirect jobs, the nuclear industry currently plays an essential role in our industry.

With its safety and security requirements always reaffirmed, the operation of the French nuclear park has experienced no major incidents.

The main actors in the French nuclear industry, born in the 70s, are today global players. First and foremost we find:

• EDF, operating a fleet of 58 power plants in France and 15 in Great Britain, is the world's largest producer of nuclear electricity. EDF as the constructor of this park and, as an operator, has accumulated more than 1000 reactor years and has an experience that has no equivalent in the world;
• AREVA is present at all stages of the nuclear fuel cycle, in the design and supply of boilers or nuclear islands, as well as services to the operating reactors (replacement of certain components of the nuclear island, and operation during shut down). This group estimates that its overall market share of the nuclear cycle (reactors and services) is approximately 20%;
• ALSTOM is now one of the world leaders for conventional nuclear islands for nuclear power plants (PWR and BWR type). Approximately 30% of the operating nuclear plants in the world use the turbine-generators developed by this group;
• Bouygues and Vinci, global players in their field of civil engineering and works of art, are historical partners who have contributed to the construction of the entire French park through companies that have been consolidated to form these two groups.

In addition to these major industry players, there are about twenty companies of intermediate size and several hundreds of small and medium size enterprises. This network of companies, including about 200 specialized in nuclear energy play an essential role.

Finally, one should also mention the Atomic Energy and Alternative Energy Commission (CEA), the Nuclear Safety Authority (ASN), the Institute for Radioprotection and Nuclear Safety (IRSN) and the National Agency for Radioactive Waste Management (ANDRA) as important players in the industry.

Furthermore, GDF-SUEZ owns and operates seven nuclear power plants in Belgium.

Thanks to the success of its civilian nuclear industry, France can legitimately claim to occupy a prominent place in the current renaissance of civilian nuclear power in the world. However, long recognized as a model in the sector of civilian nuclear technologies, France is witnessing the degradation of its image.

The credibility of both the EPR model and the ability of the French nuclear industry to successfully build new plants have been seriously undermined by the difficulties encountered on the Olkiluoto site in Finland and on the third Flamanville reactor.

Similarly, while the average capacity of nuclear power worldwide - measured by the capacity factor Kd - has increased significantly over the past fifteen years, the French nuclear plant capacity has sharply declined in recent years

It is therefore important to quickly rectify the situation, by taking the necessary emergency measures, and thus enable the French nuclear industry, which has the capacity, to position itself in the new civilian nuclear power markets. Otherwise the credibility, and therefore the very existence of this industrial tool around AREVA would be threatened.

It is therefore recommended to**:**
• Ensure the support of the French actors, under the responsibility of AREVA, to enable the completion of the construction at Olkiluoto in the best conditions;
• Establish a priority action plan of under the responsibility of EDF, to ensure the construction of Flamanville 3 in the best conditions of cost and time;
• Define and implement an action plan to improve the availability of French reactors, including improved management during shut downs;
• Continue and increase the exchanges between EDF and the ASN to determine how the demands of the ASN can be met while limiting the impact on the duration of the plants' shut down

It also follows from these findings and recommendations that **some lessons learned for the Olkiluoto, Flamanville 3 sites,** and Le Taishan (China), **should be imperatively carried out before starting the actual construction of Penly 3.** The schedule of operations in the United Kingdom will benefit from this same concern.

II - THE REACTORS MARKET

The installed nuclear capacity worldwide is about 375 GWe (with about 440 reactors in operation). All prospective studies consider an increase in global nuclear capacity in 2030. In total, according to the scenarios, 175-520 GWe would be replaced and constructed by 2030, according to the assumptions selected for the extension of licenses. In comparison, the cumulative power that came on line worldwide since January 1, 2000 was only 31GWe. But, these projections do not anticipate a real acceleration of new on line plants before 2020-2030

In early 2010, the IAEA identified 57 reactors under construction worldwide (almost

55GWe). This corresponds to an annualized average rate of about 10 GWe of new constructions. It is reasonable to anticipate a doubling or tripling of this rate of construction for the medium-term. A determined player in this market, whose ambition would be to corner a quarter, could foresee a construction capacity between 5 and 6 GWe / year.

For the French nuclear industry, the medium-term prospects are emerging very clearly: based on a lifespan of over 40 years, a fortiori 50 years, for the French nuclear power plants, the contracts to which it can contribute are mainly located in the export.

The worldwide nuclear renaissance in the context of the globalization of the economy has disrupted historical patterns. Now, the construction of nuclear plants is often achieved through international biddings. This has been the case these past years, for the Chinese Finnish and United Arab Emirates bids to cite a few.

The French nuclear industry proposes the EPR for the international market *(European Pressurized Reactor).* It is a third generation reactor, the product of a long cooperation between France and Germany, whose goal was to develop a more economical reactor with increased safety. The EPR has followed the specification requirements developed by the European utilities and met all the successive requirements of the French and German safety authorities. Therefore, the solutions adopted have been validated.

The EPR is among the best third generation models and is, at the moment a unique product, of our nuclear industry.

How to support an export policy with a single product, a fortiori so unique?

The resulting complexity of the EPR, arising from the choice of design, specifically the level of power, the containment, the core catcher and the redundancy of the security systems is certainly a handicap for its construction and therefore its cost. These factors explain, in part, the difficulties encountered in Finland or in Flamanville. **Therefore, the further optimization of the EPR should be pursued with the feedback from the reactors under construction and the knowledge of past achievements.** The optimization will be carried out jointly by EDF and AREVA, in conjunction with the ASN in order to progress in the detailed design with the same level of safety.

In addition, models smaller than the EPR seem to better suit the expectations of some customers. **Therefore, the French offer should be complemented and it should offer several competitive products for the international market.**

ATMEA 1 could be one of those products. It is athird generation PWR between 1000 and 1150 MW, currently being jointly designed by AREVA and Mitsubishi Heavy **Industries.** However, once it is certified, ATMEA1 will have real commercial opportunities only if the design studies take into account the contribution of experienced operators in particularly EDF and if a prototype reactor based on this design is constructed in a country with experience in nuclear matters.

With the same objectives, and an equivalent level of safety, the new **smaller** reactors developed by our foreign industrial partners should be taken into account. When these steps have been taken, the French export catalog will be strengthened.

Finally, the experts interviewed by the Mission have unanimously reaffirmed their conviction that the French industry will not market low cost reactors by degrading their safety compared to supposedly equivalents models.

III - THE FUEL CYCLE AND THE MANAGEMENT OF NUCLEAR WASTE

Securing the front-end

The scenario of moderate growth at the global level tends to show that overall, mining resources and other industrial capabilities needed to cover the front-end could be "easily" adjusted, provided that manufacturers have adequate knowledge and the necessary financial resources and are able with their utility customers, to **anticipate,** that is to say, decide on new production capacity, or replace outdated production capacity.

Given the inevitable long duration of exploration and then of development of a new mine, this means that on the one **hand, exploration efforts should not be relaxed, and on the other hand the security of national supply should remain an important issue.**

For the front-end, it is essential to reinforce the strategic dialogue between the government, AREVA and EDF, Areva being a leading player in mining (In 2009, it was the first largest producer with about 20% of the primary uranium production) and EDF the world's largest consumer of enriched uranium. To implement this idea, AREVA would transfer its uranium mining assets to an ad hoc company, that it would manage and in which it would retain the majority of shares; the other shareholders could be clients. In addition, such an arrangement would enable AREVA to significantly reduce its capital requirements.

Promote the French competence in the back-end

The provisions and approaches adopted to manage the fuel assemblies unloaded from the reactor (the "spent fuel") constitute the back-end of the cycle. Globally, the back-end policies are de facto divided into two categories: disposal in a deep geological repository and, reprocessing and recycling. The latter category contributes, on the one hand, to volume and radioactivity reduction of the final waste, and, on the other hand, to the saving of natural uranium through recycling.

We recommend promoting the techniques and the French expertise in the domains of reprocessing and recycling. The position of France will be, in any event, dominated by the constant concern of non-proliferation.

Realization of the repository in a deep geological formation: insure that its study is on schedule according to the law

The final waste management in France is the object of the law of 28 June 2006. This report does not see the need to question it.

This law establishes a deep repository center for which ANDRA has to meet the regulatory deadline of 2015 to apply for the license application.

It is therefore essential that ANDRA urgently defined the operational planning for the preparation of the 2015 deadline for the repository.

To achieve this objective, it is proposed that ANDRA works as a matter of urgency to associate EDF, AREVA, and the CEA in the optimized definition the repository and its implementation. At the same time, the ASN whose role in defining realistic specifications and their implementation, could be crucial should be empowered to do so.
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IV - A NEW ORGANIZATION OF THE FRENCH CIVILIAN NUCLEAR INDUSTRY

The government must strengthen its role in the organization of the French nuclear industry while adapting to the new international

Governance of nuclear power in France needs to be strengthened and tightened, to effectively ensure the control of the multiplicity of issues (strategic, political, and industrial of the sector and a real monitoring of the French supply of nuclear export.

The strategic importance and the magnitude of the missions of reflection, leadership and coordination to implement in the nuclear field justify the **creation of** a **Department of Energy or a General Secretariat for Energy under the President of the Republic.** This Department or this General Secretariat will be guided by a central management, with the necessary competence to carry out its missions and with its own budget. It would function as the secretariat of the Nuclear Policy Committee chaired by the head of state.

At the same time, the mission of the Agence France Nucléaire Internationale (AFNI) must be expanded to develop France's international action in the field of nuclear counseling. Indeed, every state wishing to engage in the development of civilian nuclear energy or with the intention to expand its fleet of nuclear power plants must create or revise a "Référentiel de sécurité". This Référentiel consists of a set of standards, plans and procedures contributing to the safety and security (internal and external) of nuclear plants and their environment. France is able to offer its cooperation in the establishment or improvement of these Référemtiels.

The state must create an industrial structure dedicated to export

The failure in the UAE has above all exposed the organizational limits of the French actors vis-à-vis first-time buyers. The outcome might have been different if, as soon as the position of the UAE became known, there had been an objective analysis of the demand, resulting in an offer with EDF in charge.

The practical organization for an export strategy should be reconsidered, keeping in mind that the accessible markets are segmented and varied, depending on whether one is dealing with countries that already have experience in nuclear electricity generation or are first time buyers. It is necessary to create an interface that can, on behalf of all the parties, identify and record the applications, interact with the potential client on the desired contractual model and, then offer a position in principle and a choice of organization with the identification of a leader and the type of desired offer. The goal of this interface is not to make offers but only to propose the most appropriate organization to the satisfaction of the customer's request. It is in fact a service company that prepares the way for the offer .

The French nuclear industry needs to close rank around its national champions associated in a new dynamic

In a market that has become global and competitive, and after some regrettable vicissitudes, it is now important that the industrial sector reorganizes itself to consolidate its strengths, reinforce its coordination and develop its export performance, tomorrow its main market.

As a rule, for the construction projects of nuclear power plants, in France as well as abroad, EDF must be the architect and coordinator of "Team France » •

Engineering plays a major role in any new construction and represents a significant share of the total cost. This is the area in which the knowledge of the various actors is not only complementary but necessarily linked for the success of the operation. The central role is held by a conductor, the architect and coordinator, who organizes the entire unfolding of the operation and manages the interfaces. He must bring together the expertise from all relevant areas and, in particular, he must have the direct or indirect knowledge of an operator to optimize the installation and benefit from the operating feedback in all the details of the final design.

In a competitive and global world, the exceptional advantage that France possesses is the ability to integrate in its offer the unique experience of EDF as an operator but who is also responsible for the overall engineering. The two models that are recognized worldwide are EDF, the constructor of the French nuclear park and who has provided its help in several export projects and, the engineering companies in the United States that have built a large number of nuclear power plants in the United States and worldwide but do not operate them.

Thus, EDF is, to this day, the only group to possess a long track record that enables it to exercise the responsibility of architect and coordinator. However, on the international scene, if a client does not wish the presence of EDF or if EDF does not wish to respond to a call for tender, the consortium that will respond will have to find an operator and an engineering firm on which to rely to dispose of skills comparable to those of EDF.

The role of AREVA

Today, AREVA combines the activities of, the nuclear fuel cycle, the design and manufacture of nuclear islands, and the services related to the operation of the plants.

The creation of a company from the mine to reprocessing is an idea that has been controversial in the past, but is less today. On the one hand, it is able to provide a full service to its customers. On the other hand, the diversity of levels and of the investment cycles results in spreading the financial risk and guarantees a reasonable average profitability over all the cycle.

The "integrated" model of AREVA is based on the cyclical character of a diversified and consistent business portfolio, but it does exempt it from achieving the rationalization of the company and a better cost control.

It is now essential to give a new momentum to the strategic ties between EDF and AREVA

EDF is AREVA's main client, and AREVA is EDF's main supplier. The ties between the two groups inherited from their past history and based on technological and industrial proximity seem to have weakened in recent years, at a time when general interest objectives have given way to commercial objectives. EDF has thus launched a process of diversification of its suppliers (mainly in the front end of the cycle); AREVA has worked to expand its portfolio of foreign clients. Although these two approaches have their logic, they have nevertheless contributed to create today's distance.

One expects that these two groups that are under public control will learn to develop their complementarities whenever the customer demand for satisfaction requires it. This could mean conducting preliminary joint reflections and analysis on a particular subject, giving each other visibility, acknowledging in a pre indentified area either a reciprocal preference, or a liberty of action, or even deciding on a particular point a common method or policy. Only a serious dialogue and a shared willingness, without ulterior motives, on the part of both parties at the highest level will **reinforce the strategic partnership. This strategic agreement is an imperative** for France to effectively unite its civilian nuclear industry internationally, to prepare for the challenge of renewing the French nuclear park, and to support the necessary stimulus for the French economy.

The review of the current world wide nuclear politic shows the fundamental role of China. For many years EDF and AREVA have been actively present in China. In this context, it is recommended that, with their experience, AREVA and EDF offer the Chinese players, under the responsibility of the State, a joint partnership contract.

It is also important to unite and support the network of small and medium enterprises around AREVA and EDF

These manufacturers need the help of the great actors (EDF, AREVA ...) to improve their offer, to have the benefits of standards ... They also need some independence to respond to requests from the major French players' competitors .

It is proposed that the government entrusts the CEA, in collaboration with the Pôle de compétitivité Nucléaire Bourgogne (PNB), a mission to identify the skills and the potential of these industries. Finally, manufacturers of "rang 2" could be encouraged to strengthen their

concerted action within an interprofessional grouping that would act as their spokesperson with the state and the major players.

Maintaining a high standard for safety and security must always be the first priority for all the players in the French nuclear industry.

• The universal imperative regarding security has not, to date, led to the adoption of global standards for civilian nuclear power.

Unlike for other sectors,the security rules are being defined at the state level where the safety requirement is also very important (aerospace, for example).

The question of what is an acceptable nuclear risk, or more generally an acceptable technological risk, is a debate that concerns the entire society and for which the answer(s) to provide belong to the political domain. However, one must note that the concept of competitiveness of nuclear power and the heterogeneity of the security rules according to the each country reinforce the relevance of this debate and the need to specify certain security requirements. The continued increase of security requirements cannot be the only reasonable rationale. In this context, it is proposed to set up, under the responsibility of the government, a task force whose mission would be to formulate proposals with the aim of addressing together, and as well as possible the safety requirements and the economic constraints, including an international perspective, and at a minimum a European perspective.

Similarly, and for consistency purposes, it is proposed to entrust the IRSN with setting up a corpus of security provisions which are in force in France in order to ensure its dissemination and its international promotion so that manufacturers can refer to it in their bids. It is not, to date, the mission of the ASN to intervene in the processes of export supply.

• In France, the government should define a balanced modus vivendi with the ASN that reaffirms its role as an independent authority.

The ASN must also continue its efforts to ensure that most people understand its decision making. The ASN’s rights and duty regarding communication concerns complex and particularly delicate topics. It is important that events of very limited consequences do not cast unwarranted suspicion on an entire technology.

Subcontracting is a major challenge for the nuclear industry.

The maintenance of nuclear power plants for EDF, in France alone, employs more than 20,000 outside subcontractors grouped in 600 partner companies, including 16,000 workers who work in restricted areas

It is proposed, referring to existing rules to establish a charter determining the working conditions that would apply to all nuclear power employees in France. This charter could be based on the Charte de Progrès et de Développement Durable established in January 2004

between EDF and the professional organizations representing the service providers for the maintenance of the nuclear facilities.

It is also proposed that any company that would work in the nuclear sector be certified by the control authorities. Such certification would be necessary regardless the status contractual of employees of the subcontracting enterprise (CDI, CDD, temp, etc. ..).

V - NUCLEAR COMPETITIVENESS AND FINANCING

In a world where the energy sector is deregulated in many economic zones (Europe, North America, ...) the question of financing the civilian nuclear industry and therefore its competitiveness, is now essential.

Civilian nuclear energy has almost no captive use, unlike other energy for example, oil with road transport. The question relating to the relative costs of electricity of nuclear origin and electricity from fossil fuel does not have a simple answer: a new oil spill, such as the recent one in the Gulf of Mexico, and its resulting damage to the environment, a new technological discovery that allows a better exploitation of non-conventional deposits of oil or gas, an increase of global warming, are all factors that may have a strong impact on the price of oil or coal, and therefore on the medium-term competitiveness of nuclear energy.

The cost of producing electricity has three main components: investment costs, operating and maintenance costs and the fuel cycle costs. **For the first component, the competitiveness of nuclear power depends crucially on two factors: the control of construction costs and the conditions of its funding.** The global financial requirements of a nuclear project are high but not exceptional in the energy sector.

What could be the conditions for private funding?

Private investors are now very reluctant. The highly capitalistic character of nuclear power should not be a deterrent in itself. In theory a nuclear power plant lends itself in an ideal way for long term financing due to its economic stability once in operation: no climate hazard, low and operating and marginal costs, provider of base load electricity, reliable tool. A comparison with the oil industry shows that this is not the amount of investment, or even the rapid inflation of their costs, which poses a problem for private investors to invest in nuclear.

A reflection on the financing of nuclear necessarily leads to the question “Is the nuclear industry like any other?”. . While there is no doubt that finding private funding is a major handicap, the fact remains that the nuclear industry has its own characteristics (risks, safety and security standards, its link with defense issues, ...)., In addition, the government remains in France, as in many other countries, the guarantor of nuclear power.

The nuclear industry must achieve an attractive competitiveness for private investment.

Wanting to create the economic conditions for the private financing of nuclear power is not an ideological choice but a reality: it is the surest measure of competitiveness of our industry. Its development will no longer be a comprehensive national program headed by the government.

Our industry must improve its competitiveness and become attractive to investors
This requires determined action by companies. This will also require a change in industrial culture.

The main areas of industrial progress are clearly identified and are already resulting in an intense effort from all the nuclear industry actors: reduction of the duration of construction, standardization and construction of the same models, simplification of the design, construction of several units on the same site, increased efficiency of plant management.

The strengthening of the competitiveness of the French civilian nuclear energy also requires genuine commitments from the government, whose main lines could be:

• Pursue the implementation of a carbon tax on CO_2;
• Push for the extension of plant operation to 60 years, while keeping to same level of safety;
• Plan a moderate but steady increase for electricity prices (in constant euros) to enable the preparation for the long term financing of the park renewal;
• Ensure that the transfer price of electricity by EDF under the Nome law covers the full cost of the park renewal;
• Pursue political efforts to obtain that all the multilateral financings earmarked for the renewable energies are also open to nuclear power.

VI - THE MEANS OF AN AMBITIOUS CIVILIAN NUCLEAR POLICY

Strengthening Public Information

The nuclear industry is and will remain a very specific sector. Indeed, nuclear power is probably the only economic activity whose future is largely determined by public opinion. **Its acceptance by the public and institutional actors is a major prerequisite for the development of civilian nuclear power.**

For the French, the nuclear contribution to France's energy independence is its trump card. Since 2005, more than 70% of the French recognize that nuclear power brings us independence. Seven out of ten believe that nuclear power is good for the economy and creates jobs. The French also cite the environmental asset of nuclear energy and the relatively low cost of electricity. Nuclear power is for many a symbol of national pride.

The management of nuclear waste requires more openness: for 60-70% of the French, it is the most compelling argument against nuclear power.

Although informing is not enough to convince, it is essential that every citizens have access to reliable information, as reminded by the European Commission in its Nuclear Illustrative Program - Communication to the Council and European Parliament on 4 October 2007.

Therefore it is proposed **to establish a national web portal,** hosted by the new Ministry of Energy, **which would post reliable and numerous information.**

In addition, it is proposed to launch in schools, starting at the elementary level a national program for energy education and for careers in the energy sector.

It is also proposed to determine the practical arrangements compatible with the safety rules in force (especially the Vigipirate Plan) in order to **reopen to the public the nuclear power plants as well as the facilities of the industrial and controllers of the French nuclear sector.**

Affirming a major role in defining international new rules of civilian nuclear power

The new industrial battle of the civilian nuclear power is now so important that it requires the governments to get involved, by sometimes abandoning their traditional positions, by strongly supporting and at the highest level the commercial prospection of their large business and by multiplying intergovernmental agreements.

A number of responsible governments, including France of course, are at the same time:

• **In favor of this rise** (climate aspects, carbon free energy, partial answer to the worldwide increase in energy demand)
• **And worried about the risks it poses:** diversion of fissile material for terrorist purposes, non-compliance with safety standards, inadequate consideration of the local geological hazards, inadequate training of engineers and technicians who operate the facilities, etc

In regards to elements of the international context (proliferation risks, renaissance of civilian nuclear power), it is desirable to support the establishment of a “global governance” of nuclear power.

The goal is to promote the **development of a nuclear energy that is accountable,** and therefore guarantees compliance with stringent non-proliferation and nuclear safety and security requirements. "Team France" should therefore:

•Fully participate in the development of international standards;
• Be more engaged in the question of the future of civilian nuclear power;
• Promote the access to civilian nuclear power for these countries wishing to acquire it, without making concessions on issues of safety, security and non-proliferation.

An R & D to match our ambitions

To ensure greater efficiency of R & D of the French nuclear industry, the coordination between the different actors, mainly the CEA, EDF and AREVA must be strengthened. It is proposed that **a strategic R & D plan be developed at the national level with the CEA, the relevant ministries and the key industries. This plan will serve as a reference for the CEA’s multi-year program and a reexamination of the CEA’s financial system.**

The research and development programs to be implemented in the field of civilian nuclear power fall into four categories:

Front-end : this front-end research, the responsibility of the CEA, in association with the CNRS and the Universities must cover the main areas, nuclear physics, materials, mechanics, chemistry, numerical simulation ...

Testing capabilities: the developments in the nuclear field often involve the use of heavy equipment such as test or research reactors, hot laboratories, sophisticated measuring devices ... This is another responsibility of the CEA who, in coordination with the industrialists, should ensure the maintenance of a suitable potential.

Support for industrial achievements: aspecially, it is important to strengthen the programs for the optimization of the third-generation of reactors (first EPR) and extend the lifetime of nuclear power plants to 60 years or more.

Preparing for the future: the inclusion in the large loan for an initial funding for the ASTRID prototype is an important decision that shows, inside as well as outside of the country, the French desire to develop these fourth generation systems.

Training and Management of the Human Resource of the French nuclear industry

The nuclear renaissance is a real challenge to rejuvenate the skills in all areas, from the boilermakers to the engineers. The generations of technicians, engineers and researchers recruited at the time of the major construction programs of 1970-1980, are retiring and must be replaced. The sector is now facing, in a short time, the dual challenge: to preserve the knowledge and the know-how, and to train a new generation of workers to support the international development and guarantee the performance of the existing fleet.

The management, maintenance and development of competence of the entire workforce of the French nuclear industry are critical to meet France's challenges and ambitions in the nuclear field.

The efforts made by the French education system are not yet up to the task. This observation refers both to the total number of people trained and to the range of professions covered.

In addition to the actions conducted by the industry players, it is now important to **define and initiate a coordinated national program for the development of competences,** which should mobilize all the parties involved: the government, the industry, the stakeholders of the French education system. This national plan could include:

• **The implementation and development of measures to strengthen and sustain jobs in the nuclear industry;**

• **The coordination of training efforts in the nuclear field at the highest level of government;**

• **The creation of a "Nuclear campus "** the International Institute of Nuclear Energy will be situated within this campus, as coordinator of training of foreign client countries and centers of excellence that France wants developed in partnership with other governments.

• The integration of "nuclear strategy" as part of a training program of the Institute of Higher Studies for National Defence (IHEDN) and the National Institute of Advanced Studies in Securit and Justice (INHESJ).

THE 15 MAIN RECOMMANDATIONS RECOMMENDATIONS

Structural measures

1. Create a Department of Energy or an Energy Secretariat, and consolidate the "nuclear" competences of the government within a dedicated management.
2. Create a service company which , prior to the offer, identifies customer needs and offers a scheme of industrial responses
3. Confirm EDF in its role as architect and integrator of "Team France".
4. Establish a charter setting out the workplace conditions applicable to all nuclear employees in France and require the accreditation of all the enterprises involved with nuclear power in France.
5. Diversify the international French offer
6. Continue the optimization of the EPR based on the lessons learned from the four reactors under construction and the experience gained from the past achievements. This optimization should be carried out jointly by EDF and AREVA.
7. Support the extension of the operating nuclear plants to 60 years while keeping the same level of safety.
8. Review and reaffirm the mission of the ASN as defined in the Transparency and Nuclear Safety Law of 13 June 2006.
9. Assign to the IRSN the mission to establish a corpus of the security provisions currently in force in France in order to ensure its dissemination and promotion abroad.
10. Require ANDRA to urgently associate EDF, AREVA and CEA to the optimized definition and the implementation of the proposed repository in a deep geological formation (CSP).
11. Establish a nuclear national web portal
12. Creating a nuclear campus

Urgent measures

13. Ensure, under the responsibility of AREVA, the completion of construction in Olkiluoto under the best conditions
14. Establish a priority action plan under the responsibility of EDF, to ensure the construction of the nuclear power plant Flamanville 3 in the best conditions of cost and time.
15. Provide feedback from the construction sites of Olkiluoto and Flamanville 3 before starting the construction of Penly 3 and within a timeframe compatible with the schedule for the United Kingdom EPR.