Nuclear power in France

Nuclear Service, French Embassy in Washington

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Table des matières

This document aims at presenting the structure and main actors on the field of nuclear power in France to the English-speaking reader.

1 An historical approach

1896 : Antoine-Henri Becquerel discovered natural radioactivity.

Until 1945 : French researchers played an important part in harnessing nuclear power for energy production. In particular, Pierre and Marie Curie, their daughter Irène Joliot-Curie and her husband Frédéric Joliot-Curie, achieved milestones in studying radioactivity.

1945 – creation of CEA : Under the leadership of General de Gaulle, the French government founded the French Atomic Energy Commission, or the CEA (Commissariat à l'Energie Atomique). Frédéric Joliot is named first high Commissioner.

1956 : A joint project between the CEA and state-owned Électricité de France was launched to develop the first all-French commercial nuclear reactor, based on natural uranium gas-graphite technology.

1960s : For a numbers of years, nuclear safety has only been the responsibility of CEA itself. Branches of activity were created to organize nuclear safety, which evolved “along the way” with technology. In 1960, the Atomic Facilities Safety Commission (CSIA) is created inside CEA.

1964 – first commercial reactor : EDF1 is operational at Chinon (on the Loire river).

1973 – oil crisis : Oil prices sky-rocketed, causing the world economy to slump. This crisis made it crystal clear that reliance on fossil fuels was too risky for France's economy, and so alternative energy sources, particularly nuclear power, were explored.

1974 : The French government launched an aggressive nuclear power program, based on the promising pressurized-water reactor American technology, that led to the standardization of the French nuclear reactor fleet. Such standardization made it much easier to replicate and operate power plants, thereby reducing costs and safety risks. Nuclear power has now, replaced most fossil fuel plants in France, and is substantially dampening the ill effects of recurrent oil price instabilities on the French economy.

2006 – "Loi relative à la Transparence et à la Sécurité en matière Nucléaire" (TSN law) : A law about nuclear transparency and safety comes into force. It creates the independant "Authority for Nuclear Safety" (ASN) and the "Institute for Radioprotection and Nuclear Safety" (IRSN), which provides technical support to ASN.

2007 : While 58 reactors are operating in France, the construction of France's first third-generation reactor (EPR), which was designed with heightened safety measure, began in Flamanville, Normandy.

Post-Fukushima : ASN said that "There will be a before and an after Fukushima". Indeed, ASN required a number of modifications to the French nuclear fleet.

2010s – towards a diversification of the energy mix : In 2010, CEA changed its name (but not its acronym) to "Commission for Atomic Energy and Alternative Energies". In 2012, President François Hollande sets the goal of a reduction of the share of nuclear power in France's electricity mix, from 75% to 50% in 2030.

2 Map of the French nuclear power reactors

France has become a world leader in nuclear energy. Its production has steadily increased since 1973, going from about 20 TWh (billion kilowatt hours) to 442 TWh in 2011. Today, 58 nuclear plants produce 78 percent of the entire country's electricity, and France is the largest exporter of nuclear electricity in the European Union. France is second in the world (behind the United States) in terms of total nuclear power generation.

A map of the French commercial nuclear fleet can be seen on ASN's website, as shown on figure 1 :

`http://www.asn.fr/index.php/S-informer/Dossiers/La-surete-des-centrales-nucleaires/Le-parc-francais-des-centrales-nucleaires`.

3 Main players

In France, as elsewhere, the nuclear sector is at the intersection of the public and private spheres.

3.1 Public players

3.1.1 "Atomic Energy and Alternative Energies Commission" (CEA)

The missions of the CEA are mostly similar to the "Department of Energy" in the United States. The CEA has a network of 14 counsellors or representatives in French Embassies around the world. Since its creation, its mission diversified :

- **Energy :**
  - It develops and acquires the technological building blocks necessary to the development of the nuclear reactors of the future (Contribution to Generation IV and GNEP research),

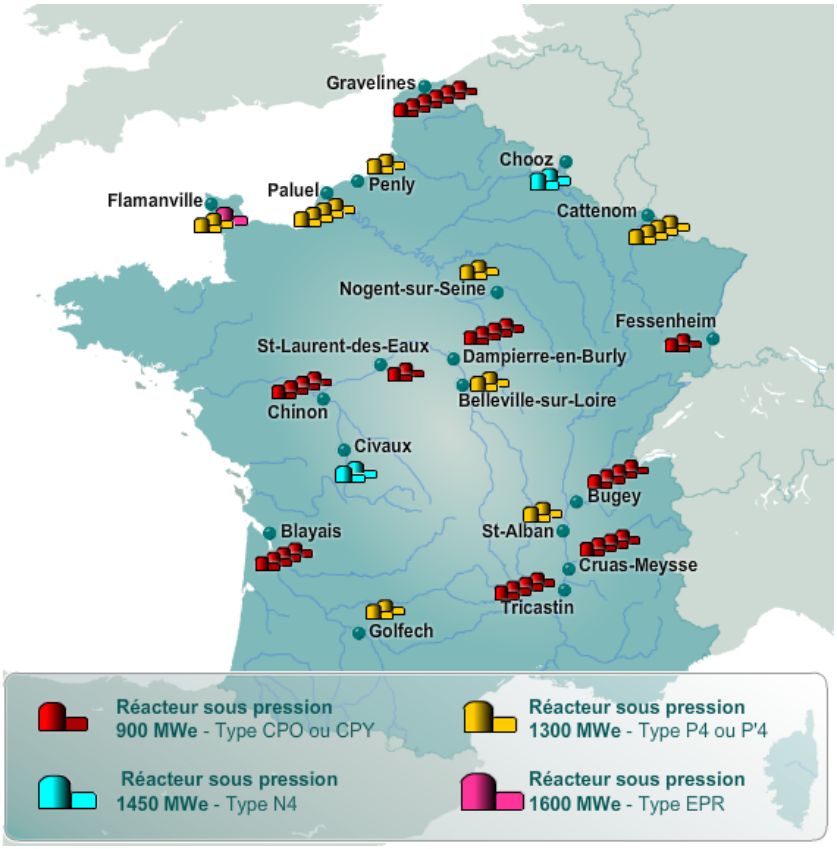

FIGURE 1 – French commercial nuclear fleet

  - It contributes to reducing greenhouse gas emission with its research on hydrogen, fuel cells, biomass, energy storage, etc.,
  - It supports the nuclear utilities in France by optimizing the nuclear power plants of the French nuclear fleet and by optimizing the fuel cycle,
  - It offers safe and economically viable technical solutions for managing nuclear waste,
  - It conducts fundamental research in climate and environmental sciences, high energy physics, astrophysics, fusion, nanosciences, etc.
- **Information and Health technologies :**
  - It tackles micro and nano-technologies for telecommunication and nuclear medicine for radiotherapy and medical imaging,
  - It researches programs on biotechnology, molecular labelling, biomolecular engineering and structural biology,
  - It shares its knowledge and know-how through education and training through the National Institute for Nuclear Sciences and Technologies (INSTN).
- **Defence and National Security :**
  - It conceives, builds, maintains then dismantles the nuclear warhead of the French deterrence force,
  - It helps to fight against nuclear, biological and chemical weapons (NRBC program).

Website : `http://www.cea.fr/english-portal`

3.1.2 “Nuclear Safety Authority” (ASN)

Created in 2006, from the former DGSNR (“Directorate for Nuclear Safety and Radiation protection”), the French Nuclear Safety Authority is an independent administrative authority which is tasked with regulating nuclear safety and radiation protection in order to protect workers, patients, the public and the environment from the risks involved in nuclear activities. It also contributes to informing the public. Like the Nuclear Regulatory Commission in the United States, it carries out inspections and may pronounce sanctions, up to and including suspension of operation of an installation.

Website : `http://www.french-nuclear-safety.fr/`

3.1.3 “Institute for Radioprotection and Nuclear Safety” (IRSN)

Created in 2001 by merging the "Protection and Nuclear Safety Institute" (IPSN) and the “Office for Protection against Ionizing Radiation” (OPRI), the “Institute for Radioprotection and Nuclear Safety” is a public organization of an industrial and commercial nature placed under the joint authority of the Ministries of the Environment, Health, Industry, Research and Defence. It is the expert in safety research and specialized assessments into nuclear and radiological risk serving public authorities whose work is complementary to the ASN.

Its scope of activities includes :

- environment and response,
- human radiological protection,
- research on the prevention of major accidents,
- power reactor safety,
- fuel cycle facility safety,
- research installation safety,
- transport safety,
- waste management safety,
- nuclear defense expertise.

Website : `http://www.irsn.fr/EN/Pages/home.aspx`

3.1.4 "National radioactive Waste Management Agency" (ANDRA)

Created in 1991, the French "National Agency for Radioactive Waste Management" is a public industrial and commercial organization that operates independently of waste producers. It is responsible for the long-term management of radioactive waste produced in France under the supervision of the French Ministries for Energy, Research and the Environment.

ANDRA also pursues industrial, research, and information activities as it designs and implements disposal solutions suited to each category of radioactive waste :

- the collection, conditioning, disposal of radioactive waste from small producers (hospitals, research centers, industry),
- specification of waste packages for disposal,
- disposal in suited sites,
- monitoring of closed disposal facilities,
- research programs for long-lived and high level activity waste, especially through the operation of an underground research laboratory in a deep clay formation.

Website : `http://www.andra.fr/international/pages/en/`

3.2 Industry

The main French industrial groups implied in nuclear energy are :

- **Reactor maker, fuel cycle and services provider :** Areva : `http://www.areva.com/`.
- **Reactor Operator :** "Électricité de France" (EDF) : `http://www.edf.com/the-edf-group-42667.html`

4 Activity of the nuclear service of the French Embassy in Washington, 2012-2013

The nuclear service in Washington has several missions :

- **Watch of American nuclear power :** Understanding its structure, following the specialized press, focus on questions such as nuclear waste, technological orientation, research and development, new nuclear, American export strategies, nuclear diplomacy, etc.
- **Likewise, providing our American partners with information about the French nuclear sector.**
- **Development and follow-up of the bilateral French-American cooperation in the field of civil nuclear.**