

## The nuclear industry in France – An overview

French scientists contributed to the main stages in the discovery of radioactivity and its properties. Right after the Second World War, the country embarked on a nuclear development programme – initially military and then civil. The nuclear industry's organisation is still heavily based upon the structures created at this key period, even if their status has developed.

The Commissariat à l'Énergie Atomique (CEA – Atomic Energy Commission), set up in 1946, was charged with overseeing the research and development, up to the industrial stage, of all the processes necessary for the military programme and subsequently for nuclear electricity generation, including the uranium extraction and fuel manufacture (upstream) stages and the management of spent fuel and waste (downstream). A branch of the public research body CEA was created to manage all its industrial activities, mainly through the Compagnie Générale des Matières Nucléaires (Cogema – General Company for Nuclear Materials), a private company set up in 1976. In 2001 this merged with Framatome, the nuclear reactor builder, to create the Areva group.

Electricité de France (EDF), a company also established in 1946 by the nationalisation of the numerous state and private companies that existed at the time, was first and foremost responsible for overseeing the development of the electricity supply across the country. From the 1960s and even more from the 1970s, this development relied very heavily upon the construction and operation of nuclear reactors. Today EDF operates all 59 nuclear reactors in service in France. In 2005–06 EDF ceased to be a public enterprise entirely controlled by the State and was privatised, although the State retained a controlling share.

In 1991 the Agence Nationale de Gestion des Déchets Radioactifs (Andra – National Agency for Radioactive Waste Management), and in 1998 the Institut National de Radioprotection et de Sécurité Nucléaire (IRSN – National Institute for Radiological Protection and Nuclear Safety, known until 2002 as the Institut National de Protection et de Sécurité Nucléaire, IPSN), were formed from internal departments of the CEA. The IRSN is a public expert body responsible in particular for supporting the Autorité de Sécurité Nucléaire (ASN – Nuclear Safety Authority). The latter, which for a long time remained an internal department of the Ministry of Industry, has gradually evolved: after initially coming under the joint responsibility of the Ministry of the Environment and the Ministry of Health (under the name of Direction de la Sécurité et de l'Information Nucléaire (DSIN – Department of Nuclear Safety and Information) and then of Direction Générale de la Sécurité Nucléaire et de la Radioprotection (DGSNR – General Department of Nuclear Safety and Radiological Protection)), it has been an independent authority since 2006.

The first nuclear reactors operated by EDF from the end of the 1950s belonged to the natural uranium/graphite/gas (UNGG) line, initially developed by the CEA to produce plutonium. These reactors, as well as several industrial-scale prototypes tested as part of the development of other lines during the 1960s, have now been shut down and are being dismantled. In 1973 the French authorities opted for a massive development of the pressurised water reactor line, using low enriched uranium. The 58 pressurised water reactors now operated by EDF on 19 sites were for the most part put into service from 1977 until the end of the 1980s. A new reactor in this line, the EPR, is under construction at Flamanville. France has also developed the rapid neutron reactor (RNR) line with two reactors: Phénix, still operated by EDF, and Superphénix, which was finally shut down in 1998.

The French nuclear industry has moreover endeavoured to control all stages of the nuclear process. The CEA developed a uranium mining industry from the 1950s, although the last French mine closed in 2001. The various stages of uranium conversion are carried out for the most part at the Pierrelatte/Tricastin site, where in 1976 France also established an enrichment plant, Eurodif. Finally, the manufacture of enriched uranium oxide fuel (UOX) is carried out in the FBFC factory at Romans-sur-Isère.

Particularly characteristic of France is its establishment of the various stages of a plutonium industry. Reprocessing began in 1957 in the plant at Marcoule, which essentially fulfilled military demands and closed in 1977; since 1966 it has also been carried out at La Hague, whose capacity has gradually been increased in response to French and foreign requirements. In addition, the industry has acquired the capacity to manufacture mixed uranium/plutonium oxide fuel (MOX), first at Cadarache with the ATPu, closed in 2003, and then at Marcoule with the Melox plant, which entered service in 1995.

The decision to conduct reprocessing has a significant effect on the options for radioactive waste management. Solutions exist for the least radioactive waste: low- and medium-level short-term waste is stockpiled at the Centre de Stockage de la Manche (CSM – Manche Disposal Centre) near La Hague, opened in 1966 and closed in 2003, and the Centre de Stockage de l’Aube (CSA – Aube Disposal Centre), opened in 1992. But the search for solutions for all long-term waste continues – most notably research into geological disposal for the most active waste in the underground laboratory at Bure. Meanwhile the waste and nuclear material awaiting long-term solution is accumulating in more or less perpetual temporary storage facilities at the various sites, in particular at La Hague.

Figure 10 Principal sites associated with the nuclear industry in France (2008)



Source: WISE-Paris