Side economics: downplaying associated costs

> *"Compared to other energy sources, nuclear power is behind in the trend towards the liberalization of energy markets. The heavy investment and research costs, the long time lag before payback, the uncertain evolution of technologies, the problem of reprocessing and waste, and the sensitivity of public opinion on security issues, all point to high industrial and financial risks that require some State involvement. […] The State control over the public industrial players in [French] nuclear industry is key to guarantee the competitiveness of nuclear power, notably through public R&D financing."*

Report of the Seminar "Energy and Society", Ecole nationale d'administration (ENA), Promotion Copernic, 2002

The cost of a nuclear reactor, as discussed in the case of the EPR, includes the investment cost and the operation cost but also many associated costs in the front-end or the back-end of its construction and operation. These include direct costs, like R&D costs, the costs linked to the fuel chain, and the costs raising from the inheritance of nuclear power – radioactive waste management and decommissioning. There are also indirect costs which might be significant, especially those arising from implementing the appropriate technical and organisational framework, like the costs of the high-voltage electric grid or the costs of assessment and control of safety and security. Official estimates usually neglect or downplay such costs.

R&D costs

The total R&D costs in public support of the nuclear industry in France can hardly be calculated due to a lack of sufficient data and the difficulty of separating out costs regarding the overlap between civil and military applications, or the share of fundamental research in CEA later used for nuclear developments. It proves even harder to identify the respective R&D costs associated with the various technologies developed in nuclear generation and the fuel chain.

Altogether, at least half of the costs of nuclear power R&D have been covered by CEA public funding. The total R&D expenditures of CEA for the civilian nuclear programme since its creation in 1946 were estimated for the Charpin-Dessus-Pellat report as €24.7 billion (FrF 162 billion) as of the end of 1998.

Economic Costs of Reprocessing in France

In France, the costs associated with the fuel chain are framed by the structural choice to reprocess – at least partly – spent nuclear fuel. The strategic decision to launch the large scale reprocessing of spent fuel from PWR reactors was taken at the end of the 1970s, at a time when uranium spot prices reached a peak that was not reached again until the end of 2006, with the price already down to half that record level as of the mid-2008. The assumption that uranium prices would, contrary to what actually happened later, remain high and rising justified a fleet of fast breeder reactors, with Superphénix as the first order, then the construction of a reprocessing plant and later a MOX fuel fabrication plant to separate and re-use the plutonium from PWRs in PWRs.

The decisions have been made, and Superphénix, La Hague UP2-800 and UP3 and Marcoule MELOX have been built, although the economic rationale, as in the terms set out by the industry and government themselves at the time of high uranium prices, had disappeared with the end of that uranium peak.

Superphénix undoubtedly proved a big loss. Ordered in 1976, the 1,200 MWe reactor was connected to the grid in 1986. It experienced various technical and administrative problems until it was permanently shut down from 1996 and its decommissioning decided in 1998, eventually achieving no more than a 7 percent load factor, with a mere gross production of 8.6 TWh over its short lifetime. The overall cost of Superphénix has been estimated as €9.7 billion (FrF 64 billion) by the Court of Auditors (Cour des Comptes) in 1996, very close to the estimate provided by its operator, the European consortium NERSA, in 1998, at €9.8 billion (FrF 65 billion, of which FrF 38 billion being paid for by EDF). Yet this does not include the stranded R&D cost and a potential rise in the future costs for decommissioning and waste management, including the storage and future disposal or reprocessing of the two cores fabricated for the reactor, one irradiated and one non-irradiated.

The case for reprocessing and MOX fabrication could be laid out just as clearly, if the global economics of the plutonium industry were discussed in an open way. The Charpin-Dessus-Pellat report commissioned by the prime minister in 1999-2000 offered a rare occasion to do so. Using real and projected costs provided by the industry, the report compared the global costs of the current nuclear fleet under various assumptions, including the status quo on reprocessing and MOX on one hand, and the theoretical scenario of a choice for direct disposal of spent fuel from the beginning of the French PWR programme. Although embedding favourable assumptions on future costs linked to reprocessing, like those of La Hague decommissioning, the report concluded that the choice of the French government in favour of reprocessing represented an increase in average generation cost of about 5.5 percent per installed GWe over the reactors' lifetime. In other words, not developing reprocessing from the start would have provided total savings of €25 billion (FrF 164 billion).

In 2003, the official DIGEC report on reference power costs acknowledged, that "for the time being, the low prices in the front-end of the fuel cycle (natural uranium and enrichment services) do not justify the reprocessing of spent fuel on purely economic grounds." But while it recognised the conclusions of the Charpin-Dessus-Pellat report as "representative of the current economics of the fuel cycle", the DIGEC used instead projected costs for the period 2025-85 (corresponding to the reprocessing of the spent fuel of a future EPR reactor). The assumptions, based on confidential discussions between Areva and DIGEC, proved less than half the costs calculated in Charpin-Dessus-Pellat (450 €/kg of reprocessed fuel instead of 1,000 €/kg or more under various assumptions). No explanation was given for cutting by half the investment and operation costs of a future reprocessing plant as compared to La Hague, apart from a clear statement on its political origin by DIGEC: "the cost of reprocessing used in the study is the cost objective needed to guarantee the competitiveness of reprocessing compared to the direct disposal option."

This fools' game of using unrealistic assumptions to preserve the appearance of an equivalence of costs between reprocessing and direct disposal might not be played for long by EDF. With more than 8,000 tHM of spent fuel stored at La Hague, representing 99.8 percent of the material stored in advance of reprocessing as of 31 December 2007, the French utility is faced with financing most of reprocessing costs. In 2007, in the first phase of working discussions preparing an update of DIGEC's 2003 report, EDF explained in a working document that it "expects the new [reprocessing] facilities to allow for some gains in productivity," but that "one must remain cautious about the final impact on reprocessing costs" and therefore, "EDF regards the values used in the report as a low estimate."

Since 1995, EDF has assigned in its accounts a zero value to its stocks of separated plutonium – as well as to its stocks of reprocessed uranium – and made it publicly clear that, if a market existed for separated plutonium from PWR fuel, "the price would be negative". EDF is for instance charging the Dutch utility EPZ (which has its fuel reprocessed in La Hague but no means to reuse the plutonium) for taking its plutonium – rather than paying for it. The liberalisation of the electricity sector presses EDF to lower its costs, including those linked to the plutonium industry. While the reprocessing and MOX contract signed for seven years in 2001 had already included an option for 2008-15, EDF only signed on to a provisional one-year follow-up agreement with Areva in April 2008.

Decommissioning and Waste Management

The reprocessing option has a strong impact on waste management policy and costs estimates. The key issue in cost calculations is the burden of final disposal of very long-lived and highly radioactive waste, set to be a geological repository by the 2006 law on radioactive waste management. Although large uncertainties prevail in this matter, refining the design is not necessarily bringing the costs down, as illustrated by projected costs published by Andra. Its estimates of the total cost of a geological disposal rose from €14.7 billion in 1996 to a range of €15.9 billion to €58.0 billion in 2003.

This 2003 estimate conveniently concluded, in line with the claim that reprocessing is reducing waste volumes, that ending reprocessing in 2010 would more than double the cost of final disposal as compared to reprocessing all spent fuel. The bias was however obvious: in the first case, the cost accounts for the disposal of all nuclear material discharged from the reactors; in the second case, on the contrary, more than half of the total plutonium and uranium inventories are transferred to an hypothetical next generation of reactors, and none of the cost arising from the management of the waste this will produce in the future is accounted for.

As the 2006 law would require dedicated funds from the operators to cover long-term costs of waste management, the Ministry of Industry set up a group with the operators to reduce the range of uncertainties in Andra's estimates. The group concluded with lower-cost estimates for the total reprocessing scenario, in the range of €11.5 to €12.9 billion. The Cour des Comptes stressed in a subsequent report that the study failed to deal with major uncertainties on the waste site, its design and inventory or size, as some of the main cost factors remained very high. It insisted that the reduced costs displayed were caused by an announced strategy that had yet to demonstrate its technical and political feasibility.

Many factors have still to be taken into account that will lead to higher costs of disposal than the current estimate. Calculation is based on the availability of a repository by 2020, but the programme is already some years behind schedule. The final conditioning of some categories of waste, representing some of the largest volumes has yet to be designed, as well as some concepts of galleries. Finally, some of the separated nuclear materials assumed to undergo indefinite reuse will eventually go to final disposal.

Long-term liabilities also include the decommissioning of one of the world's largest infrastructure of nuclear power plants, research centres and facilities of all kinds. The Court des Comptes has calculated liabilities pending on the three main operators (EDF, Areva and CEA) to a total of €65 billion (undiscounted) as of the end of 2004. This includes the decommissioning of PWRs, for which a provisional estimate of 15 percent of the investment cost is used, but also the huge costs of decommissioning reprocessing plants. However, a part of this cost might be lifted from the operators and transferred to public funding. In 2004, the provisions calculated by Areva for the decommissioning of its facilities dropped from a total of €12.2 billion to €8.0 billion thanks to a bailout agreement with CEA transferring to the state the decommissioning responsibility for the Marcoule reprocessing site in exchange for a lump sum payment by Areva of €427 million plus a commitment to a future payment of €158 million.

Structural costs

To estimate structural costs linked to the development of nuclear energy is out of reach of a simple independent analysis, for obvious methodological reasons including the difficulty of setting a limit to costs attributable to the nuclear industry and the lack of data on structural costs in general. Nevertheless, nuclear energy generates some specific infrastructural needs that can be identified and discussed on the basis of a few examples.

One obvious need linked to nuclear power is that of the appopriate electric grid to transport and distribute the electricity generated by nuclear power plants. Of course, an electric grid would be needed in any case to distribute electricity to consumers, yet the highly centralised repartition on the territory of nuclear power casts some specific needs. This is illustrated by the case of the EPR project in Flamanville, where the introduction of a third massive unit producing electricity on the site requires an additional high-voltage line to help evacuate energy from the site and transport it to areas of consumption. Although the projected line would provide a larger benefit to consumers than the evacuation of the EPR production, these benefits could be obtained through other options, some of them at a lower cost. A large part of the investment cost to build this 150 km, 400 kV line, estimated at €240 million, is therefore directly attributable to the EPR project.

The global investment costs for the development of the electricity grid (transport and distribution) from the 1970s up to 1997 has been estimated by a working group for the Charpin-Dessus-Pellat report to reach more thant €75 billion, of which more than 10 percent is for the very high voltage grid. By the turn of the century, around €2.9 billion was spent each year for developing the grid, of which 0.5 billion was for the very high voltage grid. Based on those costs, the report introduced a difference of €6.8 billion over the period 2000-2050 in a low-electricity-demand scenario, in favour of a non-nuclear, decentralised power system compared to a status quo nuclear fleet.

Structural costs such as those arising from the organisation of safety and security are even more difficult to assess. These cover, for instance, a large part of the IRSN budget – amounting to €276 million in 2006 – dedicated to public expertise and advisory work on radiation protection, nuclear safety and security issues. Or that, of course, of the nuclear safety authority, ASN and its decentralised control means in the French regions, around €50 million. The specific activities of security forces to protect nuclear facilities and transports should also be included.