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► **To cite this version:**

Claire Le Renard. The Superphénix Fast Breeder Nuclear Reactor: Cross-border Cooperation and Controversies. *Journal for the History of Environment and Society*, 2018, Special Issue: Siting Nuclear Installations at the Border, 3/2018, pp.107-144. 10.1484/J.JHES.5.116796 . halshs-02088348

HAL Id: halshs-02088348

<https://shs.hal.science/halshs-02088348v1>

Submitted on 18 Apr 2023

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The Superphénix fast breeder nuclear reactor

Cross-border cooperation and controversies

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Abstract

The “Superphénix” fast breeder nuclear reactor was a Franco-Italian-German project resulting from a shared ambition to develop new technology through European industry collaboration in the 1960s-1970s. Transnationality contributed to rendering the industrial-scale investment possible. Such projects had to be sited between partner countries, therefore it was located in Creys-Malville, between Lyons and the Italian border, yet even closer to the Swiss border near Geneva. This industrial-scale FBR prototype triggered a cross-border controversy fuelled by scientists in France and Switzerland, as well as mass protests on a European scale, followed by successive lawsuits. Focussing on the mutual influence the borders and the project exerted on each other, the paper examines institutional responses leading to the project’s reframing as a research facility in the 1990s, and subsequent developments facilitating its shutdown in 1998. The conclusion addresses the shifting geographical scales and distribution of power over the course of the project.

Keywords

Fast breeder reactor, nuclear controversy, counter expertise, Superphenix, Creys-Malville

Introduction¹

In Mid-April 2017, the French daily newspapers Le Monde published a set of photos entitled “From Chooz to Superphénix, major worksites for

¹ The author wishes to thank the issue coordinators as well as the anonymous reviewers for their valuable comments and suggestions. I am also indebted towards Arthur Jobert for his insights about debates and institutional setting surrounding nuclear energy in France. The contribution of archivists

nuclear decommissioning”² showing the progress of disassembly (Barroux, 2017). They also attest of a common past regarding nuclear sites in border regions. Four to six decades earlier, when these plants were erected, both the nuclear power plant at the Belgian border and the fast breeder near the Swiss and Italian borders were projects of great ambition: of progress and modernity, and of constructing European unity through transnational technological projects. In both cases, a joint project company with stakeholders from different countries and the selection of a site close to the border of the partner countries was to affirm and perform the spirit of European cooperation. Since the 1950s, the European Communities, notably Euratom, framed and promoted such projects. Such plants embodied European cooperation in very concrete terms, and the deliberate siting of such projects at inner-European borders underlined their mission of ensuring peace through economic and technological transboundary cooperation.

Ironically, however, when nuclear power became controversial in the 1970s, these very projects raised transboundary (or cross-border) issues, triggering tensions between the neighbouring countries and their societies. As defined in the introduction to the special issue: “Transboundary issues relate to a problem which is due to a shared border between two (or more) neighbouring countries (...). They result from external, cross-border effects of risks or pollution, which are at geographical proximity” (Kaijser – Meyer, 2018a). In other words, citizens at the other side of the border have to live with the nuclear risks, while not having a direct say on the plant. “Transboundary issues trigger a variety of transboundary relations between different kinds of actors, at different geographical and political scales”. Such transboundary relations are at the heart of the analysis, which focuses on the transboundary history of a specific nuclear project, the fast breeder reactor called “Superphénix”. The paper examines the influence the borders and the project exerted on each other.

This project “Superphénix” was set up in 1970 by the state-owned utilities from three neighbouring countries: the French EDF, the West German RWE, and the Italian ENEL. As was usual at the time, members of the consortium chose to site the prototype plant close enough to partner countries in order to materialise the cooperation, share the industrial contracts and the benefits of new technology developments, and deliver

and interviewees who helped in accessing written material should also be acknowledged. Despite of this, the views expressed here are entirely of the authors’ responsibility, as well as any errors and/or omissions.

² All translations from French documents are mine, which won’t be specified in the further quotations.

the partners their share of electricity generated by the plant. Therefore, it was sited in Creys-Malville (France), a rural location east of Lyons, roughly 100 km from Italy. But the Franco-Swiss border near Geneva was even closer to the plant. This border was already a site for international nuclear physics, as in 1965, the European Organization for Nuclear Research (known as CERN) had extended its particle physics laboratories to span the border. France and Switzerland had conducted cooperative projects on nuclear physics and nuclear power plants. Moreover, they had a long history of cooperation in hydroelectricity dating from the 1920s (Varaschin, 2003). Resting on such a history, could nuclear-related issues become sources of tensions between countries maintaining good neighbourly relations? And could the closeness to the borders influence the course of the Superphénix project?

The usual narratives of national programmes of nuclear power plants (NPP) tend to omit that experimental reactor projects were in a number of cases deliberately located at an intra-European border both to facilitate and to symbolise cross-border cooperation in research. Transnational cooperation in developing new technologies was intended to materialise promises of a future European industry bound to conquer new markets.

This oversight in the literature also holds for fast breeder programmes (Fjaestad, 2015). They are commonly mentioned as a side subject in the broader picture of nuclear development. After the Second World War however, nuclear developers regarded Fast Breeder Reactors (FBRs) as the flagship of nuclear technology. By using “fast” neutrons, these reactors can “breed” a future load of plutonium-based fuel while generating electricity. Between the 1950s and 1970s, at a time of rapid economic growth and increasing electricity consumption, many countries developed FBRs hoping to gain access to what appeared to promise a nearly inexhaustible source of electricity (Sauvage, 2013). In such a vision, the logical end-point of a viable nuclear programme consisted in a fleet of commercial FBRs complemented by reprocessing plants designed to recover the plutonium that had been “bred” and convert it into new fuel. Specific research and development plans scheduled the build-up of research reactors and prototypes of increasing size, also supported by the Euratom research programmes of the European Communities. FBR technology would become an object of international competition, technological development, future energy visions, and risk debate, engendering abundant literature. In particular, its reliance on a plutonium-based fuel made fast breeder technology a prime target of anti-nuclear protests, because plutonium was associated with nuclear weapons, the concerns about proliferation, and safety and security concerns, including Robert

Jungk's (1977) spectre of the "nuclear state", liable to limit civil liberties in order to ensure nuclear safety (Meyer, 2014).

The findings underpinning this paper mainly rely on the study of written material, as well as around fifty interviews with project proponents and critical experts. Indeed, the controversy about Superphenix generated many publications: essays, pamphlets, articles and interviews in the general press, at a national or regional scale, which could be used. The archives used were either institutional (mainly French National Assembly and EDF) or obtained from or via interviewees. The latter documentation, kept in home offices or garages for decades, originated in the first place from the CEA, EDF, their trade unions, and the Socialist party. As Tauer (2012) highlights, the distinction between primary and secondary sources is artificial for many documents regarding this controversy. Indeed, research publications contributed to the debate they were analysing. Therefore they were ordered into "published sources" in case of hesitation.

This paper provides a new perspective on the Superphénix case by paying attention to geographical scales in the actors' discourses and imaginaries, and the distribution of power across borders. It discloses how the project promoters' imaginaries regarding energy issues combined the scale of the whole world with more nationalist views, while commercial perspectives were envisaged in a European framework. This transnational project was set up by utilities, but governmental support in each of the partner countries was essential to its realisation. Opposition to the project started at a local scale, but quite quickly embraced a transnational and translocal European activists' network, and the paper investigates how its centre of gravity moved towards Geneva, coordinating cross-border activist networks on several fronts: with demonstrations, expertise, and court challenges. Lastly, the paper deals with the shifting role of actors and institutions over the course of the project. This case reveals how French institutions provided some space for counter-expertise (Topçu, 2008), both national and cross-borders, with consequences on the project's course.

The outline follows the chronological development of the project and the controversies it triggered. The first two sections consider an initial period ranging until 1976, when borders were regarded as a privileged place for the setup of a transnational NPP project that would become a transboundary issue. Both following sections examine the joint development of a worksite and a cross-border controversy, from the governmental decision to commit to the project in 1976 to the plant's start-up in 1986. The third period is dedicated to changing institutions and debates around the operating prototype plant, until the government's decision to shut it down in 1998.

Setting up a transnational FBR “industrial prototype”

Different accounts of the emergence of the Superphénix project reflect the built-in ambiguities of French nuclear developments in the 1960s, combining nationalistic views in an international technological competition with a rather flexible stance towards European cooperation and American technology. According to affirmative nationalist narratives usually encountered in France, Superphénix succeeded its predecessor Phénix in an apparently natural sequence of national FBR projects, making up for a late start in international competition (e.g. Vendryes, 1997). The European narrative traces a genealogy of FBR projects fostered by Euratom in the 1950s and 1960s, and later by the union of the European electricity industry (Marth, 1993). The actors involved in the project tend to emphasise one dimension or another depending on their organization. After paying special attention to the reconstruction of genealogies in the actors’ narratives, the paper underlines the negotiation work which proved necessary to have the transnational project started.

According to Hecht (2009), post-war nuclear development in France aimed at crafting a national identity and rehabilitating “French grandeur” lost during the World War II. Like in the other European countries discussed in the contributions to this special issue (Kaijser-Meyer, 2018b; Rubio et al., 2018; Kirchhof, 2018), specific institutions were created to develop nuclear technology to serve similar purposes. First, the Atomic Energy Commission, *Commissariat à l’Energie Atomique* or CEA, was established already in 1945 to lead nuclear technology development. Later on, the discussions and decisions took place within and between public institutions: the CEA, the utility EDF (*Electricité De France*, founded by a nationalisation law in 1946), the specialised advisory Commission “PEON” on Nuclear Energy Generation, created in 1955 (Simonnot, 1978), the General Commission for Planning, and the government. They defined the shape of a nuclearised future, on the backdrop of concerns regarding energy scarcity – given France’s lack of domestic fossil fuels – and international competition about developing nuclear energy generation. Research reactors embraced several combinations of nuclear fuel, moderator and coolant. The CEA’s main project was the in-house development of gas-graphite reactors fuelled with natural uranium, but it also investigated alternative designs: a small light-water reactor (LWR) for submarine propulsion, heavy-water, high temperature, and breeder reactors.

European utilities were primarily interested in reliable and efficient power reactors, and thus regarded the signature of contracts between the newly-founded Euratom and US LWR technology providers as an

opportunity to implement a design which benefited from a significant experience in the United States (Frost, 1991; Mallard, 2009; Radkau, 1983; Nielsen, 1999; Kupper, 2006). In France, EDF sought to evaluate the real performance of options other than the domestic design, the CEA's gas-graphite technology. It saw joint projects in the context of Euratom as a way to emancipate from the national setting, an opportunity for collaboration and learning. In 1958, a Franco Belgian LWR project was planned at the border in Chooz. In a nationalised electricity sector, a European NPP required an adjustment of the law. Thus, a 1958 ordinance allowed Euratom-funded electric plants on French ground, provided EDF possessed more than 50% of the project company (Gaulle, 1958). In this case it owned 51% (Dänzer-Kanthof-Torres, 2013: 83-84). Further projects were considered later on. Projects fostered by Euratom had a distinctly European dimension, intended to symbolise the resolute will for an enduring peace along with diplomacy and industrial policy, hence siting such specific projects close enough to borders seemed obvious. The experience of transnational projects in other novel nuclear technologies created a framework which would facilitate the Superphénix project.

But in the mid-1960s, national stakes became more important again. While gas-graphite reactors were built, concerns about fuel scarcity and economic efficiency became predominant in French planning documents, thus fostering technologies enabling a better use of the energetic potential within uranium fuel (CEA, 1966). Yet already in the mid-1950s, Georges Vendryès, a CEA engineer, had succeeded in convincing the CEA to invest in research about FBR technology after having visited the United States on an invitation in the context of the Atoms for Peace programme. The CEA initiated a project for a fast breeder research reactor in 1958, named Rapsodie for RAPide SODIum, with the help of Euratom funding (Vendryès, 1997). As soon as the Rapsodie research reactor entered operation in 1967, a new project team started to design the "Phénix" FBR prototype, with the size of a standard coal-fired power plant of the time – 250 MWe. Some engineers felt that organizational hassles had outweighed the benefits of Euratom funding, therefore "Phénix" was launched in a national setting (Interview 1).

In the late 1960s the "war of the systems" raged in the French nuclear establishment between the proponents of the nationally developed gas-graphite reactor and of the LWR, already commercialised in the United States. In late 1969, the government decided to stop the attempt to develop an industrial-grade gas-graphite reactor (Vichney, 1969). Consequently, the only remaining "national" nuclear technology was the FBR, which became an object of consensus, concentrating technological enthusiasm as well as expectations regarding its economic viability (Hecht, 2009:

291-293). In the 1960s, the UK was winning the race for the first FBR demonstration reactor in Dounreay (Lehtonen-Lieu, 2011) but the French Phénix plant was due to make up for lost time. In its 1969 annual report, the CEA hailed the French success regarding breeder reactors in a global competition, however the nationalistic rhetoric did not mention the Euratom funding of Rapsodie. The report further announced that the French FBR programme included a 1000 MWe industrial prototype power plant, to be launched in the next five years (CEA, 1970: 5). It would later be called the Superphénix.

As a result, the origins of the Superphénix project are often told as the story of a linear development within the CEA (e.g. Vendryès, 1997).³ But another narrative emphasises the genealogy of a European FBR project, stemming from attempts inside Euratom. Nuclear agencies in other European countries were also considering FBR prototypes. Beyond the prototype plants in the UK, a transnational German-Dutch-Belgian project called SNR 300 was developed for a site in Kalkar in the Federal Republic of Germany (FRG), close to the Dutch border (Tauer, 2012), and Italy considered the PEC (*Prova Elementi di Combustibile*), a project dedicated to fuel testing for future industrial-size FBRs (Gerlini, 2017:141). Engineering teams started to design future 1000 MWe FBR plants in order to identify key features of 250 MWe FBR prototypes plants. In the late 1960s, European utilities were concerned with the need for new generation capacity to meet the rapidly rising demand (Ehrhardt, 2012) and the waste of resources due to lack of coordination in FBR development (Gerlini, 2017:144). Under the auspices of their European-level interest organization *Unipede*, several electric companies initiated a discussion in 1969 and made plans for a 1000 MWe FBR to be set-up in a transnational industrial cooperation (Giessen, 1989: 56-63).

The setup of Superphénix thus results from the combination of two strands, although narratives usually emphasise one or the other. One is nationalist, pursuing a world rank for French nuclear technology at a time when the country adopted industrial LWRs under American licence. The other is European, setting up a transnational industrial project embodying Europe and modernity, in line with former Euratom projects sited close to borders. It then could be flexibly framed as a French or a European FBR project by institutions that would commit to it. Their display of ambition provided the project with a momentum enabling it to persist through the

³ As always in the history of technology, one should be cautious about the innovators' narratives: this book was written in 1997 to defend the Superphénix plant after the discourse by the Prime minister announcing its shut-down, in a hope that it would be restarted.

tensions that would occur during the negotiations. This paved the way for a nuclear prototype of an unprecedented size being sited close to an intra-European border.

The 1969 French programme for FBR development mentioned above matched with other utilities' ambitions regarding this technology. Indeed, in an article about Italian ENEL's president, he is depicted as the initiator of this European collaboration (Anonymous, 1974). In 1970, EDF, the German utility RWE, and Italian ENEL set up a working group for the construction of sodium-cooled FBRs (Scheuten-Braun, 1970). Unlike contemporary working groups on other promising technologies, the FBR group reached an agreement and obtained the support of utilities. In July 1971, they signed a "letter of intent" to consider two common industrial prototype FBRs in the range of 1000 MWe, in order to share costs and new knowledge, to be sited respectively in France and in the FRG. Each contracting party was committed to finding financial support for innovation from its government (EDF-ENEL-RWE, 1973). Meanwhile, the CEA and EDF-Equipment Division studied possible plant designs. In order to take advantage of economies of scale, they decided in 1972 that the size of the plant in France would be 1200 MWe rather than 1000 MWe, with the partners' agreement. At the time, no NPP of this size existed worldwide.

Why then, was the Superphenix located in Creys-Malville, not far from the borders to Italy and Switzerland? Siting decisions in general were made by combining several criteria: need of electricity generation; geographical considerations such as available space, roads, railways, cooling source such as the sea or an important river, low seismicity; and ecological, esthetical and social criteria (Foasso, 2012: 290). At the time, it was common European practice that any transnational technology development project had to be sited close enough to the borders of the participating countries, or alternatively industrial sites had to be distributed in every country, as in the case of Airbus. Interviewees emphasised that the partners' remuneration in the form of electricity supply implied siting it near the border to avoid electricity losses, which is consistent with Chambru (2016) and Lucas (1979). A former executive in the engineering division remembered in an interview that the Superphénix project had to be sited close to either Germany or Italy, and that the engineering division in Lyons was more interested in implementing FBR technology (Interview 3). Therefore, EDF studied two possible sites situated east of Lyons and chose a site located by the Rhône River, close to the hamlet of Malville, in the municipality of Creys-Pusigneu, in the Isère *département* (county). This site is located about 100 kilometres from the Italian border, and it is even closer to the Swiss border



Figure 1: Map representing the Creys-Malville site and the relevant cities and borders.

Source: author, map © OpenStreetMap contributors, openstreetmap.org

(see Figure 1). However, the country closest to the site, Switzerland, did not participate in the project and does not appear in project documents consulted in this research. Although high level discussions on cross-border nuclear issues between French and Swiss authorities had already started in 1964 around the Franco-Swiss Kaiseraugst LWR project, near Basel in the border region (Kupper, 2003: 48-52), no evidence indicates if Superphénix was discussed.

As was usual for its industrial sites, EDF named the site with elements referring to its location: “Creys-Malville”. The three names mostly used for this plant indeed reflect three visions of it. Superphénix (Super-Phénix in the earliest documents) designates the technological project, in line with the CEA’s tradition of naming each prototype according to its features. The name

Creys-Malville refers to the plant and the site in its local and industrial setting. While organising the protest in the 1970s, opponents preferred the name of the hamlet, Malville, for its negative connotations (in French “Mal-Ville” sounds like “Evil-City”). Later on, as cross-border expert critique and legal actions became predominant, opponents used both other names to designate the plant, and Malville remained related to the intense mobilisation, site occupation and demonstrations in 1976 and 1977, a moment in space and time.

It must be mentioned that with the Superphénix project becoming European, parliaments were involved in changing the laws nationalising the electricity sector in France⁴ and in Italy. In France, an ordinance had enabled Euratom projects since 1958 but it was not applicable. Thus in December 1972, the French Parliament discussed a law enabling the “creation of companies in the electricity sector carrying out an activity of European interest on the national territory”. The terms of their debate considered the risk of foreign companies leading to the loss of energy independence and sovereignty, on the backdrop of the abandonment of the “French” gas-graphite technology. Contrastingly, the technological choice of FBR development rallied a broad consensus among elected representatives, which stressed that France would become the leader in FBR technology (Assemblée Nationale, 1972: 6136). New laws were passed in France (1972) and Italy (1973), enabling the industrial partners to finalise their agreement. It stated that the construction of an FBR power plant of 1000 MW or more should be initiated in France in 1974, one year after Phénix’ commissioning (Phénix had started up successfully in 1973). Moreover, the industrial partners’ agreement stated that a second 1000 MW plant should be built in Germany, using the technology retained for the Kalkar reactor, and keeping with the rapid pace of deployment – one year after Kalkar’s commissioning (EDF-ENEL-RWE, 1973).

A transnational project becoming a transboundary issue

In 1974, a limited company called NERSA was created to own the Superphénix plant. Its capital was distributed according to the agreement: the EDF held 51%, ENEL 33%, and RWE 16%. In order for an NPP project to proceed to a concrete-and-steel plant, two governmental decrees were necessary, related respectively to safety licensing and “public benefit” (Caillousse, 1980).

⁴ According to the 1958 French constitution, they were not included in the list of decisive actors in the energy sector (Turpin 1983), but they intervened in the vote of the laws establishing the five-year Plans for the industrial and economic development of the country.

In 1973, the Ministry of Industry setup a new department, the Control Service for Safety of Nuclear Installations (SCSIN), to conduct the safety licensing process. This formalised process established in 1973 put an end to the CEA being responsible for both nuclear development and safety licensing, yet in different departments (Foasso, 2012: 244-246). This was in line with international development to separate the promotion, research on the one hand and the regulation of nuclear power on the other, e.g. in the UK in 1971, and the US in 1975. Nevertheless, safety licensing for an industrial-scale FBR was especially challenging for governmental experts, as it was a “world first”. The limited global operating experience of FBRs provided less established knowledge on safety than for other nuclear technologies implemented at the time (Foasso, 2012: 332-345). The outcome of the procedure would be a “decree authorizing creation” (of the plant).

Moreover, as any new infrastructure, a NPP required a decree ‘declaring public benefit’ which required a local and written consultation procedure called a “public benefit investigation”.⁵ In the summer of 1974, the public benefit investigation around Creys-Malville gathered only seventy comments, but the first local anti-nuclear NGO (“association for the preservation of Malville and Bugey sites”) had it cancelled on a technicality (documents were not numbered and initialled). Therefore, a second investigation had to take place later in 1974, and this time, no less than 657 observations hostile to the project were addressed to the Commission of investigation, gathering almost 2000 signatures. In this consultation, the risks of a full-scale prototype of this novel technology were emphasised by scientists acting as critical or counter-experts: the biochemistry professor Philippe Lebreton, from Lyons University, founder of the regional NGO for nature protection FRAPNA (Fédération Rhône-Alpes de Protection de la Nature), and the physics Nobel Prize recipient Lew Kowarski, a researcher at nearby CERN in Geneva, who had contributed to the successful start-up of the CEA’s first nuclear pile “Zoe” just after the war. The final report by the Commission of investigation was favourable to the project, on condition that safety and security would be reinforced, communication and dialogue would be enhanced,

⁵ In French, “*enquête d’utilité publique*”. *L’utilité publique* – translated here as ‘public benefit’ – is pivotal in French law regarding infrastructure projects. The primary purpose of a “public benefit investigation” is to ensure that due compensations are paid to the individuals and private sector entities potentially affected by a project of ‘public benefit’. Therefore such investigations are limited to the municipalities close to the site and designed to collect written or oral comments from the citizens, over a short period of time. This process was reformed several times since 1974 (Jobert-Le Renard, 2016).

and debates would confront divergent scientific views on the project (Commission d'enquête, 1975). At the same time, university researchers in Grenoble produced alternative energy scenarios (IEPE, 1975). Starting from a Lyons-Geneva-Grenoble triangle, the controversy would soon encompass a significant part of continental Europe.

Meanwhile, the industrial set-up required time, delaying the launch of the Superphénix project. In 1975, more countries took part in the project company NERSA. The German RWE was substituted by a group including stakeholders from the FRG, Netherlands, and Belgium, SBK (Schnell Brüter Kernkraftgesellschaft mbH). But in France, the Ministry of Economy and Finance criticised the high costs entailed by the rapid pace of the nuclear programme as a whole. Moreover, the Ministry of Industry was keen to cap its financial contribution to Superphénix. In early 1976, high-ranking actors in nuclear decision-making stated in interviews with specialised journalists that the Superphénix project had been awaiting a decision for too long; some even doubted that it would be approved at all (Verguèse, 1976; Simonnot, 1978).

In February 1976, at a Franco-German summit, President Giscard d'Estaing highlighted collaboration in FBR development (Giscard d'Estaing, 1976), and two months later, the government "authorised EDF to approve an order for Superphénix in 1976, on the condition that its partners in Nersa will contribute their due share" (Ministère de l'industrie, 1976). In interviews, some project actors claimed that the diplomatic dimension could have helped Superphénix in being launched (Interview 2). Diplomatic implications of a transnational setup can be a meaningful rationale to initiate and continue expensive experimental projects which none of the partners would fund on its own, as McCray (2010) analyses for the ITER project.

The successive moves summarised in this part make it clear that the decision to build Superphénix was in fact a stepwise process. These stages involved many actors on a European, national and local scale to stabilise the transnational project: FBR funding, utilities' joint letter of intent, law amendment, transnational agreement, and public benefit investigation. The transnational setup of the project helped it to gather momentum (Hughes, 1987). Meanwhile, the growing opposition to the project began to straddle the Swiss border, turning the transnational fast breeder project into a transboundary issue, and triggering a variety of transboundary relations.

The simultaneous construction of the plant and cross-border controversy

After the Superphénix project gained its official green-light, the cross-border controversy grew in scale and scope, and the demonstrations by anti-nuclear NGOs are usually remembered. Nevertheless, Superphenix

was also the target of a dedicated “expert critique” by scientists, CFDT trade union members and Socialist party members closest to ecological stakes, some of them working at EDF or the CEA (Jobert-Le Renard, 2016; Hatch, 1991). Even supporters of LWR industrialisation could criticise a FBR development they deemed too hasty, and especially Superphénix’ ambitious design as an “industrial-scale prototype”.

The movement organising antinuclear demonstrations had transnational and trans-local dimensions (Tauer, 2012; Tompkins, 2016). Indeed demonstrators against the Superphénix worksite came from all over France and across the borders from neighbouring countries. “For demonstrators, Malville was the central and most repugnant element of the entire system of nuclear power, an especially expensive, high-risk, and unproven technology that produced ‘the most toxic substance the world has ever known’” (*Politique Hebdo* of 1 April 1976, quoted by Tompkins, 2016: 171). This substance is plutonium, pivotal for the breeding cycle.

In July 1976, a peaceful site occupation took place for several days, inspired by precedents in Wyhl (FRG) and Kaiseraugst which had succeeded in delaying nuclear power plants worksites (Kupper, 2003). The European dimension of the issue seemed to overwhelm the grassroots-oriented “Comités Malville” which had envisioned a small-scale protest for July 1976 and needed this opportunity to coordinate between themselves and the plant’s neighbours. But “somewhere between 5,000 and 20,000 demonstrators came from across France, as well as Germany and Switzerland to participate” (Milder, 2016: 152).

The police used violence to terminate the site occupation. The Comités Malville met in February 1977 to plan a demonstration for the next summer, yet the controversy over the use of violence divided the participants, which could not reach an agreement. The debate continued in activist journals such as “La Gueule Ouverte” until the week before the protest. Some German activists brought along gear for the demonstrations that they had also used in Brokdorf and Grohnde – such as motorbike helmets –, which was viewed as particularly provocative by the French police. The French police also investigated their German counterparts’ experience in dealing with mass demonstrations, but misunderstandings were caused by the different demonstration cultures (Tompkins, 2011). On 31 July 1977, the police blocked access to the construction site several kilometres from the fence, and the violent repression of a numerous crowd (20 000-60 000) in the middle of the fields ended up with the death of one non-violent activist, Vital Michalon, and three severely injured. The mutual perception of German demonstrators and the French police had consequences for the German-French relationship, yet without leading to diplomatic tensions (Tauer, 2012).

This tragic event became a turning point. Activists considered this experience as a defeat and gave up on further large-scale antinuclear demonstrations in France (Tompkins, 2016: chapter 5). Drawing on Touraine et al. (1983), many academic observers of the French anti-nuclear movement have claimed that the violent outcome of the 1977 demonstration marked the end of the active mobilisation against the project⁶ (e.g. Rucht, 1994). However, in line with most recent research, it should be highlighted that mobilisation did not cease, but a change in style and focus occurred. After abandoning mass demonstrations, some activists dedicated themselves to the creation of green parties (Milder, 2016) or other environmental causes (Ollitrault, 2008). Therefore, some scholars refuse to judge the anti-nuclear protest as a “failure” or a “success”, as it had broader positive consequences for the people involved (Tompkins, 2016: chapter 6). Moreover, in Germany, this demonstration gave an unprecedented notoriety to the stakes of FBRs, which contributed to the mobilization against the planned Kalkar prototype (Tauer, 2012).

The “expert critique” of FBR development in public hearings has not yet received much scholarly attention. In September 1976, the departmental council of Isère (the representative assembly of the *département* hosting the site, with a Socialist majority) organised a two day-conference involving project proponents, experts and scientists critical of the project, and elected representatives. They experimented with a formal framework to discuss science and technology, with an explicit reference to the American model of parliamentary public hearings (Jobert-Le Renard, 2016). In their closing address, the locally elected representatives debated the stakes and uncertainties of energy policy and of the project. They asked for a moratorium, hence they entitled the proceedings: “Creys-Malville, the Last Say?”. But their motion for a halt to the project remained unheard and the departmental council subsequently filed a case against the French state, which was later rejected.

Discussions on the future of FBRs also took place abroad. From 1976 on, the UK and the US delayed their industrial-scale prototype projects, relying on reports by pluralist expert commissions weighing FBR benefits against the risks raised by plutonium use and high costs. Scientists involved in the nuclear controversy imported this debate into France. For instance, they translated critical views on FBR industrial development from the

⁶ This conclusion stems from the research design: sociologists working with small activists groups attempted to help the anti-nuclear movement become a driver for political change comparable to the workers’ movement, but they judged that the 1977 demonstration marked “the inability of the anti-nuclear current to organize itself into a political force” (Touraine et al., 1983).

British report on “Nuclear Power and the Environment” (Flowers, 1976) in the popular science magazine “Science et Vie” (Martin, 1976).

In December 1976, 1326 scientists from the Geneva-based CERN “countersigned an open letter addressed to Mr Giscard d’Estaing, as well as to the Belgian, British, Dutch, Italian, and West German Heads of Government, calling for a halt of the construction work on the Super-Phénix breeder reactor at Creys-Malville, 80 kilometres west of Geneva” (Vichniac, 1976). In June 1977, 500 scientists from Grenoble published a comparable open letter. And the 1975 founded GSIEN federated the action of scientists from other French universities (Topçu, 2008).

The controversy surrounding Superphénix addressed to what extent the plant was “experimental” or “industrial”, as its framing as an “industrial-scale prototype” left room for ambiguity (Jobert-Le Renard, 2014; Le Renard, 2015, 2016). CFDT union and socialist party members inside EDF and the CEA highlighted the contradictions of the project’s design, as the novelty of the technology required precautions they felt were not taken. The Socialist party conducted an intense reflection on energy issues from 1975 on. Its platform for the 1978 legislative election included a moratorium on Superphénix and its redefinition as a smaller, research-oriented prototype. These actors regretted that the French institutional setup did not leave a place for an official, adversarial debate before the decision. They found inspiration in the public hearings taking place in the US or the open public inquiry process and assessments in the UK, and they intended to set up new institutions. Another debate was organised by mainstream media in 1980, with a continued reference to the American “public hearings”. They convened politicians from the four major parties (all in favour of the FBR except the socialist representative), experts appointed by them, and people from “the public” (Jobert-Le Renard, 2016).

Thus, it is important to stress that beyond the slow-down of mass protests following the tragic 1977 Malville demonstration, still other forms of critique, but less visible, remained unaltered. The success of the Left in 1977 local elections gave them hope that they would win the 1978 legislative elections. The Socialists’ 1978 electoral program included a halt of the Superphénix project together with a change in French institutions responsible for technology decisions, but they did not reach a majority. Meanwhile, on the other side of the Swiss border, activists renewed their forces.

Activists from Switzerland, a country that did not participate in the project, but with the closest border, would play a crucial role in developments of the Superphénix case. Geneva had hosted the “Atoms for peace” conferences in the 1950s and the CERN in the 1960s, but in the early 1970s it became a place of nuclear controversy. At Verbois, a site located by the Rhône River downstream from Geneva, a planned

1000 MW plant triggered debate and was finally cancelled. The city's institutions included nuclear enthusiasts as well as concerned opponents. Indeed, the Swiss federal constitution offered specific political opportunities for groups critical of nuclear installations, such as referenda initiated by citizens (Kriesi et al., 1992; Kitschelt, 1986b). The related campaigns triggered broad debates around nuclear projects, e.g. in Basel (Rens, 1995). In 1978, the antinuclear mobilisation had already obtained projects postponements in Switzerland.

In October 1978, some thirty Swiss intellectuals, professors and elected representatives, most of whom were working in the universities of Geneva or Lausanne, launched a "Geneva Appeal" underlining risks entailed by the construction of Superphénix seventy kilometres from Geneva. This letter sent to parliamentary bodies of all European countries asked elected politicians to create a "broad-based public debate and a consultation of the concerned populations on replacement solutions for the Superphénix breeder reactor in Creys-Malville and the plutonium society" (Bach, 1990: 157). As a petition, the "Geneva Appeal" gathered 50,000 signatures. Subsequently, the "Organisation for the Geneva Appeal" (*Association pour l'Appel de Genève* or APAG) was founded. It disclosed large excerpts from its correspondence with various European political bodies in a "Yellow Book on plutonium" in 1981. As had already happened just after the war (Mallard, 2008), scientists placed themselves above nation-states, on a transnational scale, for the sake of humanity. Convinced that their expert knowledge qualified them to better address the issues raised by plutonium, they attempted to warn national and supranational elected authorities. Beyond the Superphénix, the APAG also extended the stakes to the theme of 'Energy and Society', a topic on which it co-organised a series of conferences inviting adversarial views, with the subtitle "FBRs, real or false issue?" (*Les surgénérateurs, vrai ou faux problème?*).

In several countries, academic research produced knowledge aimed at influencing the course of FBR projects. Economists in France and Germany contended that FBRs were economically inefficient (e.g. Finon, 1982; Keck, 1980). Scholars in legal research compared the institutions enabling and controlling nuclear in France and other countries (e.g. Turpin, 1983). Sociologists and political scientists conducted real-time research on the ongoing nuclear controversy, sometimes implementing a comparative research perspective (Nelkin-Pollak, 1981; Kitschelt, 1986a).

Meanwhile, some Swiss activists resorted to violence and sabotage. They attempted to draw a clear line between violence against material objects, which they accepted, and violence against people, which they rejected even if it almost happened (Tompkins, 2016). Twenty years

later, Chaim Nissim, an elected representative at the Council of Geneva, revealed his participation in around thirty power tower bombings around Creys-Malville, and in a bazooka attack against the worksite in 1982, including weapon procurement by a terrorist group (Nissim, 2004).

In traditional friendly Franco-Swiss neighbourly relations, nuclear-related issues triggered new discussions and agreements. According to diplomatic rules, Paris' relevant interlocutor was the federal government in Bern, and high-level discussions convened official departments dedicated to safety licensing. In October 1979, they concluded a Franco-Swiss agreement regarding the exchange of information on events liable to have radiological consequences. In 1985, before the start-up of the plant, meetings were held between NERSA, the relevant French ministries (Home affairs, Foreign affairs, and Industry, namely SCSIN and Energy directorate), and the Swiss authorities. A report by the Swiss delegation after these technical talks, dated 27 August 1986, mentioned that the breeder reactor "meets the stringent safety requirements set for modern light water reactors". Since the mid-1970s, risks had been the focal point of a controversy mobilising scientists and activists, in public arenas. No argument on safety could demonstrate the total absence of risk, therefore risk discussions and safety discussions co-existed in the form of a dialogue of the deaf. However, the activists in Geneva felt not represented by Switzerland's federal government in Bern.

Constraints and tensions in a transnational project with transboundary implications

The construction site too integrated the constraints of transnationality. Some foreign engineers moved to the building site with their families. According to the usual "Fair Return" rule governing international projects, 33% of supplies had to be Italian and 16% German, as to reflect shares in the company. The lack of standardisation across countries made the advanced design and engineering more complicated. The working organisation and habits that had proven useful for Phénix were thoroughly changed, partly due to the transnational character of the project and partly because of the industry organisation, entailing substantial coordination costs. With the French nuclear programme privileging LWR standardisation and massive orders to a national industry, the once-central FBR project became progressively peripheral inside the nuclear sector itself.

Moreover, discussions with the German partner about the next FBR became problematic. The 1973 agreement envisioned two industrial-size FBR plants, the second of which had to be sited in Germany. But in

early 1976, EDF judged Superphénix' design too expensive for a future commercial FBR. In its view, the design for the next plant should be a simplified and optimised version of Superphénix, thus French stakeholders negotiated renewed cost criteria deemed to achieve "competitiveness". In 1979 they agreed on an almost unattainable objective, which can be interpreted as a first downgrade of the FBR project, from a future fleet to an ever-furthering prototype. But this scenario remained very ambiguous, as the engineers continued to work on the design of possible future plants. This also rendered flexible the definition of this once transnational project, as some engineers dreamt that the next plant could be entirely French. Press articles from the 1980s and 1990s reveal contradictory statements from members of nuclear organisations (EDF, CEA...). In the specialised or local press (e. g. Varlet, 1986), FBR developers, being rather optimistic regarding technology and costs, mentioned a FBR fleet in the short-medium term.⁷ But in the national daily newspaper *Le Monde*, the head offices of the same institutions highlighted uncertainties, combining the former arguments with different visions of the future, leading to an imperative to wait. Yet they expressed their view in very ambiguous terms, in order not to impede FBR technology development (Augereau, 1984; Gordon-Maurus, 1984).

Their announcements not to commit to the envisioned industrial FBR plant took diplomatic considerations into account, as the indeterminate postponement of Superphénix' follow-up caused tensions with the German partner. Declarations were accompanied by statements such as "the research programme on FBR remains in force, as do the collaborations between European countries (Belgium, France, Great Britain, Ireland, Italy, and the FRG) which, last January, signed an agreement on a programme for upgrading breeder reactors" (Gordon-Maurus, 1984). This programme is known as the European Fast Reactor or EFR (1984-1993), which remained a "paper reactor". Indeed, R&D agreements can be understood as a way to

⁷ Simultaneous statements in the media by members of the same organisations contradicted each other, which makes it especially difficult for the researcher to figure out which the official plans were. For instance Fjaestad (2015: 106) writes "Five such power plants were envisioned", but archives show that they were nothing beyond a view of EDF's Equipment Division in the late 1970s, not validated by the general director on the backdrop of rapidly changing hypotheses. Only one future FBR pre-industrial power plant had its features negotiated and designed, and it ended up indefinitely postponed. This statement rests on the minutes of the so-called "Article 1 Committee", available at EDF, CEA or National archives, a source also mobilised by Hecht (2009) or Foasso (2012).



Figure 2: The almost completed Superphénix plant, 1984.

Source: Yann Forget, CC-BY-SA-3.0, Wikimedia Commons, reproduced with permission.

slowly decrease involvement in a project, while enlarging its borders – the UK was included at last. When the governments did not want to pursue the serious build-up of prototype plants, but keep the engineering competence available, they encouraged European projects that would develop “paper reactors”. But utilities could not find an agreement for the EFR to proceed further than R&D, and in 1986 this problem emerged on the Franco-German diplomatic scene (Finon, 1989: 220; Marth, 1993: 39-41).

The plant’s start-up in the wake of Chernobyl

The Superphénix plant started its operation in early 1986, four months before Chernobyl, and it was terminated by a French governmental decision in 1997, followed by a decree in 1998. From 1987 on, an intense controversy unfolded. Debates took place in institutions that had changed since the 1970s, partly as a consequence of the socialist critique described above.

In 1985, fuel was loaded into Superphénix’s core. After ten years of construction, the Superphénix industrial prototype was finally completed (see Figure 2) and began its industrial operation. In January 1986, the electricity generation unit of the plant was connected to the grid, without much publicity. *Libération* stated ironically: “yesterday, its coupling with the EDF grid was far from being the world event that the Superphénix foetus foreshadowed” (Anonymous, 1986).

Four months later, the Chernobyl accident changed the setting for the nuclear debate in countries concerned with the Superphénix project. In West Germany, responses to Chernobyl were characterised by an intense media debate about the potential dangers of the radioactive contamination (Kalmbach, 2013). During the campaign for the referendum about a nuclear phase-out in Italy, six elected representatives entered the Creys-Malville site to protest against Italian participation in the FBR. They destroyed Italian flags and ENEL signs (Anonymous, 1987). In November 1987, the referendum resulted in a decision to dismantle the existing nuclear sites and stop all new construction. Nevertheless, ENEL maintained its participation in NERSA. Renegotiating the 1973 agreement proved difficult between France and Germany, hence the EFR industrial agreements were signed only in 1989, after a transfer from the diplomatic level to a utilities' association (Marth, 1993: 52-55).

In Switzerland, the anti-nuclear NGO Contratom (founded in 1985 to oppose a nuclear world exhibition in Geneva) raised awareness on nuclear issues by demonstrations (Di Stefano, 2016). A constitutional initiative entitled "Energy, our business", launched in 1980, was submitted for a referendum, and adopted by the people of Geneva on 7 December 1986 with a majority of 60% (Rens, 1995). As a consequence, the constitution of the canton was amended by a new article stating that "the cantonal authorities shall use all legal and political means at their disposal to oppose the installation of nuclear power stations, high-level and intermediate-level radioactive waste repositories and reprocessing plants in and around the Canton" (Cst-GE, 1986). This transboundary provision extended beyond the limits of the authority which had issued it, considering that a potential contamination in neighbouring regions could have consequences inside the canton of Geneva.

Chernobyl certainly was a moment of political opportunity, an external event that could shift the rules of the political game, but change did not occur overnight in Geneva. The amendment in the constitution was indeed the result of more than a decade of mobilisations, open letters, petitions and debates by intellectuals and activists. Although in a much less visible way, slow changes in institutions occurred in France too during these years. The 1981 elected socialist parliamentary representatives created a Parliamentary Office for Evaluation of Scientific and Technologic Choices (OPECST or *Office parlementaire d'évaluation des choix scientifiques et technologiques*) in 1983, as a result of their reflections in the late 1970s about democratizing significant technology decisions such as the nuclear programme. After Chernobyl, the OPECST entrusted itself with reviewing nuclear safety on a yearly basis. Its first scientific board included scholars actively involved in the nuclear controversy, e.g. the

mathematician Pierre Samuel, a key member of Friends of the Earth. The French branch of this NGO had been a key player in anti-nuclear activism in France since the early 1970s (Meyer, 2013). The OPECST conducted public hearings allowing the different parties to express their views in an official arena, producing the debate scheme whose inexistence was deplored by many in the 1970s.

The OPECST 1987 report expressed the concern that an independent agency should be responsible for controlling nuclear safety, instead of the SCSIN department inside the Ministry of Industry. A first step towards opening occurred when this department was “attached” to the State Secretariat of Risks, which was later merged into the Ministry of Environment (Saint-Raymond, 2012: 144-145). In this new context, in March 1987, after just one year of operation at Creys-Malville, a sodium leak occurred in a key component of the fuel handling system, called the “cylinder” fuel storage tank. The occurrence of an event rated with such a low probability led to intense expertise activity regarding other possible leaks, especially a careful re-examination of all welding radiographies. The repair involved changing the whole fuel handling system, which now differed from the description included in the 1977 decree authorizing creation. Thus the decree was invalidated and the plant’s start-up was bound with a new decree mentioning the new fuel handling system.

Further protest structured by Swiss NGOs

In response to this event, anti-nuclear NGOs in Geneva structured themselves with new commitments and new methods. Contratom organised demonstrations at chosen places such as the French Consulate, Embassy, or the Franco-Swiss border (Bach, 1990: 102; Chambru, 2016). Yet the federal level in Bern, in line with its domestic nuclear policy, had more confidence in the existing safety institutions than near-by Geneva. There are indeed three institutional levels in Switzerland, the Commune, the Canton (or State) and the Swiss Confederation (in Bern); each of these levels rests on a legislative assembly and an executive assembly. Regarding Superphénix, divergent positions between Geneva and Bern, or even between the executive and legislative branches of the same level, as well as between parties inside one branch, were constant throughout the period (Bach, 1990: 99-108; Rens, 1995). To address French authorities about Superphénix, the legislative assembly of the “Republic and Canton of Geneva” had first to urge its executive counterpart to refer to Bern. It did so in 1987, “to demand the organisation of an international expertise about Superphénix”. In May 1988, Bern answered negatively, referring to the international rules established by the IAEA which “did not provide

for the opening of an expertise at the request of a third country, but only if the country in which the safety investigation is to be carried out expressly so requested" (Enerpresse, 1988a). In short, Bern did not want to break diplomatic rules and friendly relations with its neighbour.

As a safety reassessment was a matter of concern, in September 1987, the APAG raised funds to finance a counter expertise about Superphénix's safety. They commissioned nuclear safety specialists at the University of Munich, the professors Benecke and Reimann, to carry out an independent assessment of the Creys-Malville power plant (Birraux, 1992: 207-225). In autumn 1988, "the various NGOs (*associations*) in a way divided up their tasks: WWF made its judiciary competency available, APAG dealt with the scientific dimension and Contratom carried out more militant actions", a Swiss journalist recounts (Bach, 1990: 104). The WWF mobilised both its Swiss and Geneva branches (Colson, 1991). Demonstrations organised by Contratom helped maintain awareness of the issue, and the core of the action consisted of financing counter-expertise or lawsuits. This all required fundraising, which was especially successful in Switzerland.

As the work progressed in the plant, NGOs were concerned that it could be restarted before the full commissioning of the new fuel handling system. In November 1988, WWF and other Swiss and French NGOs hired lawyers to oppose the restarting of Superphénix. In France, they retained C. Huglo and C. Lepage, famous for winning the 1984 trial against the Standard Oil Company on behalf of Breton localities affected by the 1978 Amoco Cadiz oil spill. They had pleaded other cases of international environmental damage which would contribute to establishing environmental law (Bourg et al., 1995; Renaudie, 2015). In an attempt to prevent the restart of the plant, they filed an application for a suspensive "emergency report" with the Grenoble Administrative Court, which appointed an independent expert to verify the implementation of planned security measures. In November, the city of Geneva joined the proceedings initiated by the Swiss anti-nuclear NGOs. Mid-December, the expert was invited on the site by NERSA, as well as the SCSIN safety department, the lawyer C. Lepage, and the NGOs: the Swiss WWF, APAG, and the French regional FRAPNA. As project proponents and opponents met directly, some became aware of the distance between their respective causes and values, which made it so difficult to understand each other. F. Chappaz from Swiss WWF stated: "the most worrying with these men is that they are convinced of the quality of their technology, they are sincere with themselves" (Politis, 1989).

In late 1988, the Geneva government once again asked the Bern government to intervene vis-à-vis Paris in order to obtain better guarantees regarding the expected restart of Superphénix. But Bern indicated that it did not intend to oppose the restart of Superphénix and would simply

insist on the safety provisions of the plant, even if it might be redundant with the French Industry Minister's statement that he would follow the advice of SCSIN (Enerpresse, 1988b, 1988c). After a joint meeting, the ministries announced the establishment of a Franco-Swiss Commission for Nuclear Safety and Radiation Protection (CFS), which would extend the 1979 agreement to an international law convention. Henceforth the institutionalised discussion included the downstream located Bugey NPP in France as well as Swiss nuclear installations within the framework of the CFS, which held annual meetings (IFSN, 2011; Mitterrand, 1990). Members of the commission included representatives of the French SCSIN and, on the Swiss side, representatives of the Federal Nuclear Safety Inspectorate and Federal Offices of Energy, Public Health, Foreign Affairs, the National Alarm Centre and the cantons.

In January 1989, the French Prime Minister signed a new "decree authorising creation", modifying the 1977 one as to reflect the changes regarding the fuel handling system (Rocard, 1989: 458). The Industry Minister and the Risks State Secretary, then supervising the SCSIN, granted their authorisation for a plant's provisory restart. Both administrative acts, the decree and the authorisation, were objects of several lawsuits, of which only the outline is summarised here. Swiss NGOs and FRAPNA immediately filed several cases in France to suspend the authorisation, and later Swiss municipalities and the Canton of Geneva joined them in the lawsuit. The Grenoble Administrative Court rejected the case asking for a new "emergency report" which would suspend the ministerial authorisation to operate the plant (Bach, 1990).

A case was filed at the *Conseil d'Etat*, the highest administrative court of France. It targeted a precise article in the new decree authorizing creation, as in the plaintiffs' view the repair caused a substantial change to the plant, which rendered necessary a renewed public benefit investigation. Another ground cited for appeal was infringement of Article 34 of the Euratom Treaty, which provided for the Commission's assent before carrying out "particularly dangerous experiments" likely to affect neighbouring countries (Colson, 1991). NGOs considered bringing the matter before the Court of Justice of the European Communities in Luxembourg (Bach, 1990), but the Court's records do not indicate any such action.

Activists called for an official, pluralist debate. In February 1989, the Rhone-Alpes Regional Council hosted public hearings, but not decision-making. Contratom organised mass demonstrations gathering several thousands, in Annemasse, Bern and Geneva (Bach, 1990: 99-104).

In late August 1989, following a request by NERSA, the plant's ministerial authorisation to operate was extended. In protest, Contratom organised regular demonstrations in front of the French consulate in

Geneva. In September 1989, in an attempt to consolidate the struggle at a continental scale, seventy-five NGOs and organisations from several European countries established the “Europeans against Superphénix” Committee (Avrillier, 1991). It was coordinated by NGOs closest to the border, thus French, Swiss and Italian: Comité Malville (Lyon), Contratom (Geneva), FRAPNA (Grenoble), Greenpeace (Paris), GSIEN (Orsay), WWF (Milano).

Unprecedented official hearings: “Transparency can also be borderless”

In 1990, air entering the argon atmosphere above the reactor through a defective membrane in an auxiliary circuit started oxidizing the primary sodium, which was detected in July and led to another stoppage of the plant. An intense controversy unfolded consequently. The safety and the purpose of the industrial prototype became the overriding concerns. The safety issues were addressed by interaction between technical experts and led to major works being carried out; in the 1990s, they were also discussed in official and public arenas where the activists’ debate on risks could meet the official answers in terms of safety. In the end, Superphénix remained at a standstill for four years, its authorisation to restart being delivered in August 1994.

This incident led to a thorough public reassessment of the project in a thoroughly revised context. Superphénix would have no industrial successor in the short-term because FBRs were broadly recognised as expensive and the concerns about fuel scarcity had faded away, as the global development of nuclear energy was totally different from what had been imagined in the early 1970s. The two technical incidents made clear that the once-deemed-nearly-industrial Superphénix was a prototype and thus required specific expertise, in order to learn lessons about the technology and to guarantee its safe and reliable operation. Moreover, in May 1991, as a consequence of the 1989 cross-border legal actions, the *Conseil d’Etat* partially annulled the 1989 “decree authorizing creation” [of the plant], therefore ministers had to elaborate a new decree and to justify their reasons publicly. Nevertheless the *Conseil d’Etat* rejected an infringement of the Euratom Treaty, considering that Superphénix was not a “particularly dangerous experiment” (Colson, 1991).

Meanwhile, in 1990, the OPECST conducted public hearings about the issue of long-life nuclear waste in an unprecedented way for nuclear issues in France (Barthe, 2009). On 19 May 1992, in a continued display of ambition to “democratise nuclear choices”, the OPECST organised

a day of public hearings regarding ‘the possible restart of Superphénix and the future of FBRs’, at which some attendees and speakers came from beyond the borders. NERSA spoke for the different partners, and recommended restarting the plant in order to gain operational feedback on industrial-size FBRs and to reimburse some of the investments by selling electricity. French activists as well as APAG, Contratom and the Swiss WWF argued for a shutdown, given the experienced technical difficulties and the uncertainties regarding safety. A letter from the Italian branch of WWF was attached to the hearings’ report, it emphasised the 1987 referendum as an argument not to restart Superphénix. Representatives of the concerned local authorities were heard, the French ones advocating the plant’s restart, whereas those from Geneva insisted on cross-border risks in case of an accident. The *Rapporteur* Claude Birraux, an elected representative, answered this concern by stating: “Transparency can also be borderless”, and thus confirmed and enacted the OPECST’ ambition to enable opening-up and transparency in nuclear issues.

During these parliamentary hearings, the French Ministers of Industry, Environment, and Research gave their views on the plant’s purpose and safety. Considering the flexibility of FBR technology, able to “breed” or “burn” fuel, the Research Minister proposed converting Superphénix into a research facility. Indeed, the outcome of the OPECST’s treatment of the nuclear waste issue had been a law reopening the choices other than geological disposal by fostering research on the feasibility of high-level nuclear waste incineration. Superphénix was one of the few practicable facilities to test this option (Birraux, 1992). On 3 July 1992 the Prime Minister decided that it would be restarted, its purpose changed towards research, and its safety reinforced by heavy works which were to be completed before restart. But the plant having been at a standstill for more than two years, its decree was invalidated according to French law, and a new public benefit investigation was necessary.

Superphénix as a research facility: Cross-border lawsuits targeting the changing purpose of the prototype

From 1992 to 1994, a diversity of tasks were carried out in the stopped plant. Onsite, safety-related heavy works involved concrete and steel. To make Superphénix exist with a new purpose in a new setting, heavy files were prepared for the public benefit investigation and safety assessments. To comply with the decision, project proponents elaborated a “knowledge acquisition plan” and had it reviewed by academics outside the CEA,

which was a novelty. Moreover, lawyers worked on a new decree authorising Superphénix as a research facility.

During all this turbulence the German and Italian project partners remained inside NERSA. However, the partners agreed that ENEL and RWE/SBK did not have to pay for the consequences of a decision recognised as French, and they negotiated about the level of compensatory measures for the electricity not produced and not delivered to the partners. In February 1995, they signed an amendment to the 1973 agreement. Indeed, an Italian interviewee meant that Superphénix was one of the most interesting workplaces for an Italian nuclear engineer after the 1987 referendum (Interview 4). Nevertheless, Germany and the UK cut their funding to the European Fast Reactor project at the end of 1993 (Marth, 1993). Subsequently, the EFR team was redesigned as a small team contributing to the industrial qualification of one of Superphénix' new purposes, research on increased plutonium consumption.

Following the change of purpose, a local public benefit investigation took place in 1993 and gathered 5000 comments. "Europeans against Superphénix" organised a petition asking for a complete shut-down of the plant, signed by 22,500. They rendered the petition visible and tangible by staging the arrival of a thick book containing the signatures in Grenoble, thus insisting on the European dimension of the issue and opposing it to the local official consultation. At this protest event, the "rise in generality invoked norms of universality, well beyond the hexagonal borders" (Ollitrault, 2008: 116-117). The appeal to European Commonality also could be regarded as parallel to the European origins of the project. The APAG and Contratom were invited to further hearings by the OPECST in 1993 (Birraux, 1994). In April 1994, 300 activists walked from Creys-Malville to Paris, attempting to put the issue higher on the media agenda (Tompkins, 2016).

In the new "decree authorizing creation" passed in July 1994, Superphénix was requalified into a research facility, which meant that electricity generation would be a secondary goal (Balladur, 1994). Geneva announced immediately that according to its cantonal constitution, it would file a case against the decree. In August 1994, an authorisation by the relevant ministers (Industry and Environment) enabled the start-up of the plant. In September, the lawyer C. Lepage filed an appeal with the *Conseil d'Etat*, on behalf of eight Swiss NGOs as well as four cities and nine communes (Conseil d'Etat, 1997). They sought the annulment of the new decree for "abuse of power", on the grounds of a discrepancy between the 1993 public benefit investigation and the 1994 decree's exact wording.

After scarcely five operating months at low power and a brief connection to the electric grid, an argon leak led to another stoppage of the plant.

It took several months to design and carry out the repair required by the argon supply pipe system. In August 1995, Superphénix could start again. In October 1995, the newly-elected right-wing government (in which the lawyer C. Lepage was appointed minister for Environment) had an independent and pluralist expert commission assess Superphénix regarding its interest for research. In 1996, the Cour des Comptes accounting authority office evaluated the costs of continuing Superphénix' operation, regarded as a public expenditure item (Le Renard, 2016). In Creys-Malville, operators felt that the many problems had finally been fixed. At the end of the year, they shut down the plant for a scheduled maintenance, with the conviction that troubles were over and the industrial operation had begun at last. But on 28 February 1997, the *Conseil d'Etat* partially annulled the 1994 decree, once again withdrawing its legal existence to the concrete and steel plant sited in Creys-Malville. The task of writing a new decree created tensions between ministers which ended in a deadlock. A few months later legislative elections brought a Socialist-Green government to office. On 19 June 1997, in a development devoted to pluralism in major planning decisions, the newly elected Prime Minister Lionel Jospin announced the closure of Superphénix.

Debates occurred concerning the practicalities: would the closure be immediate, or would the plant spend the available specific fuel? Yet in February 1998, a decree terminated the plant operating time and started the deconstruction period. Later in 1998, a parliamentary "inquiry commission" organised hearings about Superphénix. The European dimension of the project and of its shutdown decision were widely debated between parliamentary representatives, project proponents and trade unions. The cross-border NGOs were only represented by "Europeans against Superphénix" and its French spokesman Raymond Avrillier. He insisted on the European dimension of their protest: "we called ourselves 'Europeans against Superphénix', because our purpose reaches beyond challenging the French [1989 restart] decision, indeed we propose a Europe-wide phase out" (Bataille, 1998). The report following these hearings aimed at terminating the debate and still heated controversy by proclaiming a kind of "peace of the brave", in a framework that had now become purely French.

Conclusions: transnationality, borders and nuclear development

Compared to other NPPs sited close to borders, developments of the Superphénix case combine the transnationality and the border issue. The Superphénix was set up as a transnational development project between

countries inside the European Communities, mainly France, the FRG and Italy. It embodied the ambition to develop a new technology, namely fast breeder reactors, in a European industry collaboration in the 1970s, transcending nation-states. Transnationality contributed to stabilizing the project, due to gradual decisions making it ever more irreversible according to diplomatic considerations. In the line of previous transnational nuclear projects being sited close to partner countries, the Creys-Malville plant was located 100 km from the Italian border, yet even closer to the Swiss border.

In the 1970s, this industrial-scale FBR prototype was increasingly perceived as a transboundary issue, because of the potential cross-border impacts of an accident and more broadly the risks entailed by a plutonium economy. This led to intense transboundary relations involving the critics of the plant: a cross-border controversy triggered by scientists in France and Switzerland, as well as mass protests, mobilising anti-nuclear activists across borders on a European scale. In 1986, Geneva amended its cantonal constitution with an article opposing nuclear facilities in its surroundings, whereas the Confederation in Bern reaffirmed its trust in institutions and co-established a Franco Swiss Commission on nuclear safety in 1989. NGOs opposed to Superphénix coordinated themselves and combined several modes of action across the border: demonstrations, expertise and lawsuits, with Geneva joining the plaintiffs. These cross-border lawsuits led to decree annulments which contributed to weakening the Superphénix project.

The focus on transnationality and borders can provide new insights on the history of nuclear energy and society. Regarding Superphénix, actors' accounts in narratives and interviews tend to make their own standpoint central, whereas a focus on borders sheds light upon changes regarding central actors and institutions over the course of the project. The conclusion further analyses three angles: first, the geographical scales in the discourses and imaginaries of the actors, then the distribution of power across borders, and lastly the place French institutions provided for counter-expertise, both national and cross-borders, and its consequences on the course of the project.

Regarding FBRs, the scales in the discourses and imaginaries of the actors ranged from the whole world to the local surroundings and back, notwithstanding ambiguous discourses considering borders and transnationality. In the early 1970s, when Superphénix was launched, its promoters thought of energy issues on a global scale and implemented them on a European scale with strong national impulses, fuelled by national concerns of energy scarcity and industrial excellence. The intervention of national governments was essential to support the project,

which did not contradict the European rationale. In the discourses of opponents, the mobilised scales were local, regional, European in the broad sense, or worldwide (Tompkins, 2016; Ollitrault, 2008). Their action highlighted a geographical Europe including Switzerland that would be concerned with fallout in case of an accident, thus contrasting it to the commercial and industrial Europe supporting a project consistent with the European Community's objectives. But the Swiss federal government in Bern would not support such action, contrary to other cases in this issue. The Portuguese government appealed to the European institutions as an arbiter in conflicts about Spanish nuclear projects with cross-border implications. The Danes used the framework of the Nordic Council to set up a joint Danish-Swedish Commission (Kaijser-Meyer 2018b; Rubio et al., 2018), thus taking the transboundary issue to an international level. But the Geneva authorities were not entitled to intervene on the diplomatic level, therefore they put their faith in the rule of law in the French Republic and the independence of the French courts. They filed many cases against the project before courts at the local (Grenoble Administrative Court) and national levels (*Conseil d'Etat*). They even considered the Court of Justice of the European Communities, thus envisioning going to the international level. The plant's operators sometimes felt they were far from Paris, the decisive place regarding authorisations. The plant's geographical position close to partner countries but closest to the Swiss border thus had a major influence on the course of the project.

This raises a second issue regarding the geographical distribution of power. A border is sometimes considered as a remote place, whereas it can be close to a major city in the neighbouring country. Would the closeness to the border have been so significant without an important city on the other side? This leads to some comparisons with the Barsebäck case in the special issue (Kaijser-Meyer, 2018). At the beginning both projects were defined within governmental agreements, but later they triggered intense opposition and controversies. While it is not a capital like Copenhagen, Geneva was nevertheless an important city, seat of international institutions, and had the power of defining its own constitution. Some actors even felt their city's "opposition to Malville is rooted in a certain ethical and cosmopolitan, even globalist tradition which, for centuries, has given this city a role incommensurate with its size" (Rens, 1995). Moreover, despite not being a capital, a city of this magnitude gathers wealth, expertise, skills, and an activist know-how to defend the environment.

Lastly, the ambiguity of the prototype's purpose, industry or research, left room for critique by transnational science in the cross-border controversy, while the transformation of French institutions in the 1990s

gave more weight to independent expertise. Since the post-War years, nuclear scientists' concerns have transcended the borders of nation-states (Mallard, 2008). Spanning the border, the international CERN contributed in making Geneva a centre for physics, whereas the international Superphénix, finally requalified as a research facility, struggled to justify its *raison d'être* in a changed energy landscape. In 1992, its redefined research purpose opened possibilities for pluralist expertise, debates and "borderless transparency", which the OPESCT representatives performed in their hearings. While making themselves central, they shifted the rules of the game and former hierarchies of French nuclear institutions (Barthe, 2009). It enabled a broad debate about the reframing of Superphénix, from industrial innovation to research, leading to repeated assessments of the plant's costs and benefits. In line with policy studies (Zittoun, 2014), we argue that the 1997 shutdown decision should be understood in the light of the lengthy and slow process which rendered it conceivable.

As transnational nuclear projects were a usual form of nuclear innovation in the 1960s, the innovative dimension of projects and the choice to site them close to borders were connected. Analysing the array of such projects located close to borders, built or cancelled, including the coordination bodies created for them and the controversies they provoked, could bring further insights in the history of European nuclear power.

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