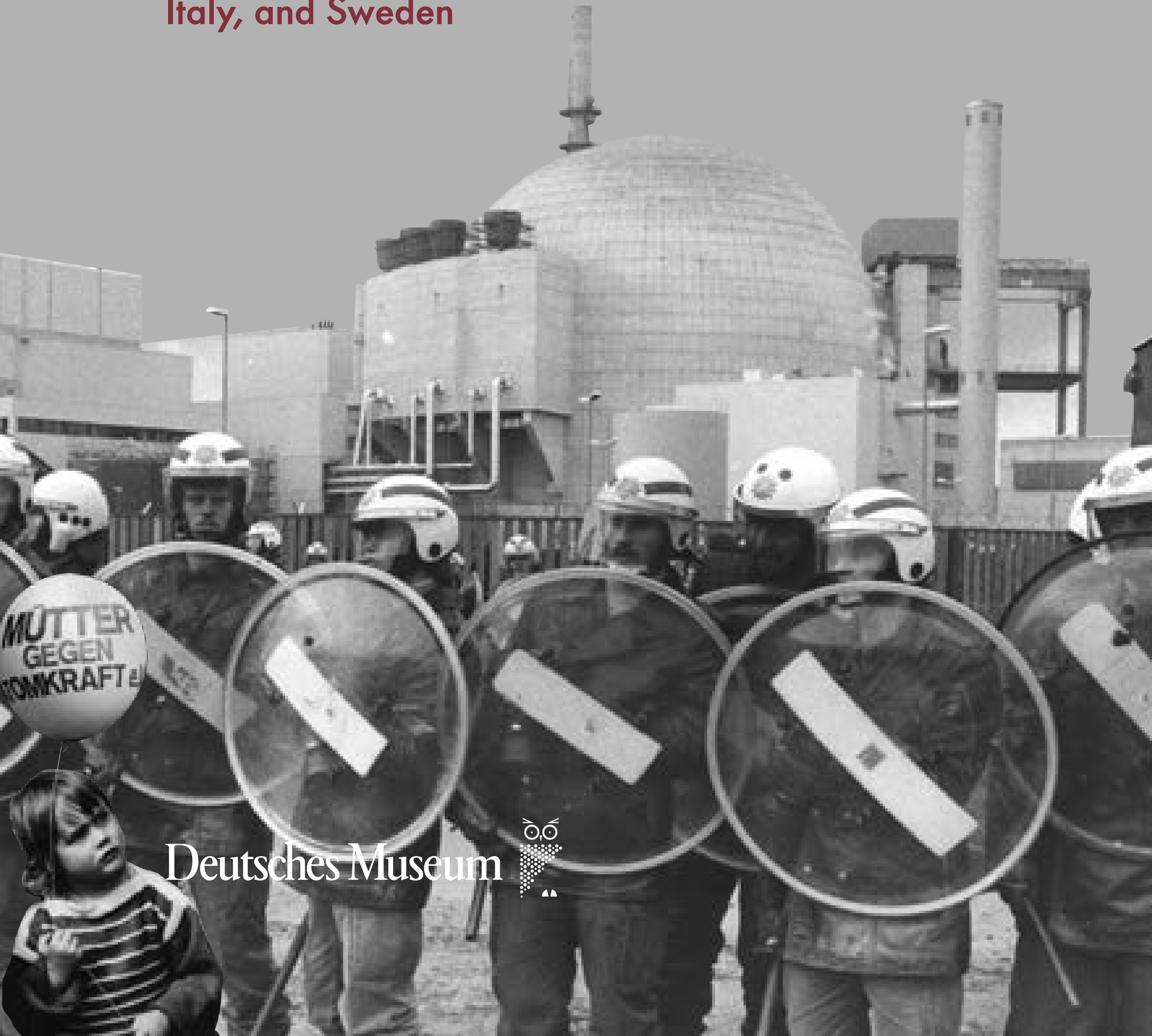
Studies 4

Astrid Mignon Kirchhof (ed.)

Pathways into and out of Nuclear Power in Western Europe

Austria, Denmark, Federal Republic of Germany, Italy, and Sweden



Deutsches Museum

Pathways into and out of Nuclear Power in Western Europe:
Austria, Denmark, Federal Republic of Germany, Italy, and Sweden

Deutsches Museum Studies

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Model of a uranium atom 1957

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Content

Astrid Mignon Kirchhof

Pathways into and out of Nuclear Power in Western Europe: An Introduction

This study examines five European countries from the period after the Second World War until the present day and asks how consistent or deviating from each other the political, economic, and cultural conditions of nuclear energy politics in these countries have been.[1] The cases selected – Austria, Denmark, the Federal Republic of Germany (FRG), Italy, and Sweden – represent a sample of nation states located in the north, centre, and south of Europe, with a set of decisive similarities, but also differences. All the countries chosen for the study are democracies with a market-oriented economy and a strong civil society that in some cases more than others developed only over time. They have all taken journeys from optimistic interest to national decisions to phase out the use of nuclear power, even if there were differences in their progress. Thus, the set was chosen to compare their pathways into and out of nuclear power. West European countries such as France and Britain and East European countries such as Russia which nowadays invest in a new generation of nuclear power stations have not been selected for this volume. Also, countries with a former dictatorship or a socialist/communist political system and a planned economy are missing in this sample. Of interest were liberal market economies with a commitment to economic accumulation. Assuming that freedom of speech is a necessary condition for a more effective protection of the environment, a further selection criteria for this volume was whether or not democratic societal debates were possible. Even though environmental movements are not always successful, they seem to be a precondition to more effectively criticize environmental exploitation and initiate the necessary changes in politics to cope with environmental degradation.

In the 1950s and 60s, in all five countries, there was widespread trust in technological progress among public servants, politicians, experts, and the media, which led to the first nuclear research programmes, centres, and reactors. The euphoric attitude towards civil nuclear power was transnationally inspired and influenced by an international effort, initiated by the USA, to pursue peaceful uses of atomic energy instead of warlike purposes. Critical voices against military and/or civilian uses were raised at a national level, often among scientists, but it was only in later decades that wider transnational, societal coalitions of critical citizens, media, parliaments, and scientists, as well as institutions were built, which went on to inspire each other.

1 This project has received funding from the Euratom research and training programme 2014–2018 under grant agreement no 662268.

In terms of the civilian use of nuclear energy, all countries under examination here took slightly different but not incompatible trajectories. In all countries, nuclear power was controversially discussed since the 1970s, if not earlier, and in each of these countries these debates culminated in a political decision – often by referendum – on the use of nuclear energy: Austria built a nuclear power plant, but after a national referendum in 1978 that was also inspired by anti-nuclear protests in other countries, the reactor never went on the grid. Two years after the Austrian plebiscite, and inspired by it, in 1980, Sweden also held a referendum and about 40% of the Swedish electorate voted for the immediate phasing out of nuclear energy. The Swedish government won the popular vote with its proposal to stay with nuclear energy production for the time being and phase it out in the far-off future. After intense societal debates and a parliamentary decision in 1985, Denmark decided against nuclear power altogether, and the country continued to rely entirely on fossil fuels and renewable energy sources. Italy held a referendum in 1987, which was triggered by the Chernobyl accident the year before, and phased out nuclear power afterwards. The German parliament, in 1998, also decided to phase out in 20 years' time, but without a plebiscite. While Austria, Denmark, and Italy have either phased out nuclear energy or never decided to adopt it in the first place, Sweden and Germany are still in the process of phasing out.

This introduction will give an overview on the most pertinent parallels and discrepancies in energy policies and politics and societal perceptions of nuclear power in the respective countries. The main part of the book consists of five country reports that deal with nuclear energy and societal interactions in Austria, Denmark, Federal Republic of Germany, Italy, and Sweden. The reports present parts of the results of the three year interdisciplinary project "History of Nuclear Energy and Society (HoNESt)" conducted by 24 partners in 15 European states and the US being coordinated by the university Pompeu Fabra in Barcelona.[2] The project brought together humanities scholars, especially historians, and social scientists.[3] The aim was to ensure that despite the diversity of historical narratives a consistent form was used that allowed to compare the different developments of national nuclear energy politics over the last 60 years. The reports were brought into a readable chapter-like form (hereinafter referred to as chapter. The national studies, so called short country reports, thus followed a coherent framework structure as can be seen next page:

2 All country reports can be downloaded via the link http://www.honest2020.eu/d36-short-country-reports. Although the volume's chapter are the result of investigations of the HoNESt project, the content of this volume is the exclusive responsibility of the respective authors and editors: Christian Forstner (Austria), Jan-Henrik Meyer (Denmark), Astrid M. Kirchhof and Helmuth Trischler (Federal Republic of Germany), Matteo Gerlini (Italy), and Arne Kajser (Sweden). For the purposes of this volume, the reports have been modified and adapted to the volume's aims.

3 The project's social scientists were: John Whitton, Ioan Charnley-Parry, Matthew Cotton, Wilfried Konrad, Josep Espluga, Gene Rowe, Ana Prades Lopez, Ann Enander, Beatriz Medina, and Pieter Cools.

List of events
– A short description of each event
– Indicators such as key decisions
– Commentary on its recognition as an important event by contemporaries
– Discussion on whether this event has become a point of reference in subsequent debates.

Identification of actors
– Promoters (or private sponsors)
– Receptors or affected people (directly or indirectly)
– Regulators and other public institutions (policy makers, etc.) (different levels)
– Arguments and behaviours
– What are the different actors' behaviours regarding the event?

Public engagement
– What type of public engagement was employed, if any?
– How did PR/public engagement by the nuclear establishment change over time?

At first glance, this very formal structure seems insensitive to the different national contexts. Yet, the potential benefit to the reader lies in the comparative and synthetic views of how present attitudes had emerged. The findings of HoNESt in general and in this volume specifically show that nuclear energy is closely intertwined with global political and scientific developments. At the same time, the results reveal the important role that individual nation states with their cultural, political, and historical particularities played in the development of nuclear power. On the one hand, national boundaries and national political institutions – governments, parliaments, and courts of law – continued to shape national energy politics; on the other hand, nation states and nation-building in post-war Europe were very much shaped by nuclear politics. This dynamic, however, was not limited to the formal political sphere. Anti-nuclear movements and protests were shaped and influenced by individual countries' cultural environments, their national economies and histories, and shaped these in turn (White 1999, Nehring 2005, 560 and 582).

The 1950s and 60s

During the 1950s, there was a common belief in many nations that, within only a few years, nuclear energy would safely and effectively provide the fast-growing amount of energy needed for a continent that was still shaken by the effects of a destructive world war. Civilian uses of nuclear power was linked to visions of a modern, positive, as well as a science- and technology-based future, and was only a controversial topic for a minority in the five societies discussed here. This euphoric attitude was in no small part inspired by President Dwight Eisenhower's launching of the "Atoms for Peace" policy in late 1953, with the First Geneva Conference on Atomic Energy, under the leadership of the United Nations, in August 1955 as its most visible public manifestation (Nash 2017). The UN General Assembly had adopted a resolution to establish an International Atomic Energy Agency and to hold an international conference under the auspices of the United Nations (Krige 2006, Kohlrausch and Trischler 2014).[4] Some 1,500 nuclear experts from all over the world participated. The conference was wide in scope and embraced all major aspects of the peaceful applications of atomic energy (Bud and Trischler 2018). Large-scale exhibitions that featured nuclear technology as a peace-making and future-saving force toured all over Europe, seeking to build an enthusiastic audience that would emphatically embrace the idea that atomic energy would enable a bright and prosperous future. Studies of responses to the Atoms for Peace exhibition, conceptualized by the US Information Services, found that the European public did not just passively receive this propaganda show by the US government, but appropriated it in a way that made sense to local audiences (Merrit and Merrit 1980, 246–247).

With Atoms for Peace not only the international civilian use of nuclear energy was promoted, the programme was above all a remedy in the Cold War. The USSR was also a nuclear power at the time, but little was known about it. The Atomic Energy Commission therefore suggested to the State Department to use the development of practical nuclear power as a trump card in the Cold War. Thus, it was possible to kill two birds with one stone: on the one hand, it was possible to counter the accusation of the Soviet Union that the US was only interested in destructive aspects of nuclear power. On the other hand, the State Department hoped to use the programme to bind allies to the United States more firmly and to induce neutral countries to cooperate in a positive manner. As a result, the Federal Republic of Germany received – with bilateral atomic agreements – nuclear fuel and nuclear know-how from the US as well as the first American research reactors, which, as in many other countries, brought about nuclear technology to Germany (Eckert 1987).

4 See also "The Geneva Conference – How it all began." August 1964. In *International Atomic Energy Agency Bulletin*, Vol. 6-3. https://www.iaea.org/publications/magazines/bulletin/6-3, accessed 19 September 2019.

Figure 1 Published drawing to support the Atoms for Peace propaganda in the 1950s promising: "With only one gram of fuel 400 times round the earth." Nuclear fuel was only used in ships and submarines, but the Atoms for Peace propaganda promised its use also in cars which was never realized though.

Atoms for Peace did not only raise expectations of nuclear energy in the political and public realm. Every player involved, whether from science, politics, or industry, followed their own political, scientific, or economic interests. In most cases, the first proponents of nuclear energy as a catalyst for technological and industrial modernization came from politics and science, not necessarily from industry. For a long time, many energy suppliers remained reluctant partners, and only supported nuclear energy if states took the financial risks, invested in infrastructures, and thus paved the way for a lucrative return on industrial investments. Numerous politicians strongly advocated nuclear energy because several countries depended on energy resources from other nations, for instance on imports of oil or coal. In order to promote economic self-sufficiency and to fuel jobs and growth by providing supposed "cheap" energy, many European nations launched a national energy plan with a strong emphasis on nuclear power. Besides the economic reasons for nation states to be independent in matters of energy, the intricate connectivity of security issues and military interests favoured the pursuit of national programmes. This is true not only for the countries under investigation here, but for almost all nations in Western Europe, including medium- sized states such as Switzerland, Norway, Finland, and the Netherlands, who launched their own, autonomous nuclear programmes during the 1950s.

Partly to complement national nuclear programmes, and partly independently from them, European governments also launched cross-national activities such as the European Organization for Nuclear Research (Conseil européen pour la recherche nucléaire, CERN). After its foundation in 1954, CERN quickly developed into a role model for both big science and transnational techno scientific collaboration in Europe. Of even more significance to this volume was the founding of the European Atomic Energy Community (also known by the shorter form Euratom), established simultaneously with the European Economic Community (EEC) on 25 March 1957 by the Treaty of Rome. The international organization Euratom was intended as a pioneering high-tech venture for the Common Market to complement the support for traditional industries, such as coal, steal, and agriculture. It thus was to promote peaceful applications of nuclear energy in Europe, above all power production. The EEC's aim, on the other hand, was to bring about economic integration among its founding members, which was achieved in 1993 when a complete single market made it possible for goods, capital, services, and people to move freely within the EEC.[5] The founding of these organizations raised high expectations on both sides of the Atlantic that they would ensure the continent's future in the field of energy and foster European integration (Rosamond 2000). Euratom's foremost research site was located in Ispra

5 The EEC was abolished in 2009 by the Treaty of Lisbon and subsumed into the European Union, which had been founded in 1993 (Preda and Pasquinucci 2010). On Euratom as an organization: Cenevska 2016.

Figure 2 This picture was published in the journal *Europa Nucleare* in 1959 to illustrate an article on Euratom's first six months of operations. The European cooperation in nuclear technology was endorsed by a relevant share of Italian leadership, with a big communication campaign; this picture shows an image of a peasant woman, as symbol for the rural population of Italy, with the cooling towers at the background promising cheap electric power especially for the agricultural areas of Italy and supported by other European countries through Euratom.

on the banks of Lake Maggiore, northwest of Milan in northern Italy. In 1960 the European Commission proudly presented Ispra as "one of the largest building sites in Europe" and a centre that eventually would employ "several thousand technicians and specialists."[6] The euphoria did not last long. Only a few years later, these great expectations gave way to great disappointment, again on both sides of the Atlantic, because the highest hopes were not realised. From a European perspective, failure to find a market for the European reactor design developed at Ispra, led Euratom into a cul-de-sac, both in terms of technology and raison d'être (Bähr 1970). From a US perspective, Euratom had failed with respect to both functions it was expected to fulfil. Because Euratom did not knit together the nuclear capacities of America's European allies, it neither blocked the nuclear projects of individual nations, such as France, nor controlled the diversion of nuclear weapons. The US government concluded that Euratom was "a pale shadow of its original grand design" (Krige 2008, 44).

In the 1950s, civil society in some countries had already turned primarily against military, but sometimes also against civilian uses of nuclear energy. These protest waves were rather locally inspired and did not show the broad scope of protest movements in later decades, but their respective arguments were often similar. For instance, critique raised by women's associations put health arguments before political or science-based considerations, which was a similar feature in national groups in different countries.[7] (Figure 2)

Pathways into and out of nuclear power

All five states under investigation in this study started off with research facilities, often following the US model of big science that resulted from the Manhattan Project, and all built research reactors imported from the US as a second step.[8] Scientists were frequently at the vanguard of national nuclear energy plans,

6 "Où en est Euratom? Un des plus grands chantiers d`Europe: Ispra." *Communauté européenne* October 1960, no 10:5; numbers after Guzzetti 1995, 25–26. In addition to Ispra, Euratom's Joint Research Centre (JRC) comprises establishments at Geel in Belgium, Petten in the Netherlands, and Karlsruhe in Germany.

7 International solidarity between activists in anti-nuclear movements started in the mid-1970s with the protest against the nuclear power plant in Wyhl, when French and German activists protested side by side (Tompkins 2016b). Some historians point to the fact that the broadening in scope of the movements in the 1970s was often restricted to prominent movement figures, while the average activist still thought more in national terms rather than considering international perspectives (Milder 2010, Meyer 2014). About women's critique in the 1950s and 1960s see Renn 1995, 762.

8 About the strong connections between the emerging nuclear power industry in Europe and the American industry see Skogmar 2004, passim.

including in Austria where they had a strong position in the national debate. The physicist Berta Karlik,[9] director of the Institute for Radium Research, a joint institute of the Austrian Academy of Science and the University of Vienna, was the central figure in Austria's nuclear research programme at that time. Karlik considered the financial requirements for constructing a research reactor were too high to make it prudent to recommend doing so. She was an Austrian delegate at the First International Conference on the Peaceful Uses of Atomic Energy in Geneva 1955. Preparing the Austrian memorandum for the meeting, she suggested an alliance of all concerned state administrations, academia, and industries to balance the financial needs. In addition, she pointed to the lack of qualified specialists, who would need to be trained first. Finally academia lost its strong position to industry and utilities which successfully urged the conservative government to join the nuclear club because they would not want to miss the opportunity to enter the market. With the aim of developing a nuclear energy production programme as well as academic research finally three research reactors went in operation in the beginning of the 1960s.

Figure 3 Physicists Berta Karlik and Traude Bernert in 1944 working with the apparatus, with which they discovered astatine. This radioactive element is produced by decay in nature and the rarest naturally occurring element. Astatine has 33 known isotopes, all of which are radioactive, and their mass numbers ranging from 191 to 223. Especially Astatine 211 is believed to treat cancer and has been used in radiotherapy to cure brain tumor patients.

9 Berta Karlik (1904–1990) was an Austrian physicist. Her assistant was the Austrian physicist Traude Cless-Bernert (1915–1998), with whom she discovered astatine.

In Denmark the situation was similar to the Austrian circumstances in the beginning, Danish utility companies and actors from industry played a minor role in the emerging nuclear sector compared to scientists and politicians. Due to the small-scale structure of Danish industry, very few companies were interested in engaging in nuclear power. Instead, the central institution involved in developing nuclear energy in the 1950s, the Danish Nuclear Energy Commission, was dominated by science. This commission was in charge of the Risø research centre, the nation's main centre for nuclear research. It carried out basic research in order to develop a 'national' reactor to support energy self- sufficiency. Up to that point, electricity had been largely imported from Sweden and the plan was to use uranium resources from Danish Greenland in a newly built power plant instead. Contrary to the other four countries in this volume, investments in nuclear research in Denmark did not, in the end, result in the construction of nuclear power plants or the development of nuclear energy supply.

In Italy self-sufficiency through electronuclear production was also considered a promising supplement to traditional energy providers. Due to a lack of coal resources in the country, Italy had tapped hydroelectric production and imported coal from abroad. Although the Ente Nazionale Idrocarburi (National Hydrocarbon Company, ENI) was carrying out a courageous policy vis-à-vis oil-producing countries, nuclear production seemed to offer a higher degree of autonomy and was appealing to industry. Thus, in Italy it was industry, especially energy-supplying companies, along with scientists, who were at the forefront of nuclear energy in the early years. For instance, the Centro Informazioni Studi Esperienze (Research and Experimentation Information Centre, CISE) had been founded by a group of technicians and scientists from the Universities of Rome and Milan (who worked with the Enrico Fermi[10] student, Edoardo Amaldi[11]) and from the largest Italian electric power company, Edison in Milan. From 1946 to 1952, CISE promoted a nuclear programme for Italy in three steps. First, they initiated an expert group; second, they launched the construction of an experimental reactor; and third, they advocated for the construction of a national heavy-water reactor, entirely designed by Italians and powered by natural uranium. The private electric companies, mainly Edison and SADE (later: ENEL), were eager to invest in nuclear power because they tried to block the State being the only player in the new nuclear power sector. The suspicion of state's (mis-) use of power was inherited from the Fascist State's intervention into economic and energy matters and was triggered in the moment when it became a relevant topic in the élite debate about nationalization of electric power (Paoloni 1994, Paoloni 2009, 46).

10 Enrico Fermi (1901–1954) was an Italian physicist that worked and lived in America. He created the first world's nuclear reactor.

11 Edoardo Amaldi (1908–1989) was an Italian physicist.

Echoing the situation in Denmark, industry and utility companies in the Federal Republic of Germany were also at first disinterested in nuclear energy because of financial concerns. PreußenElektra and Rheinisch-Westfälisches Elektrizitätswerk AG (RWE) were especially critical of nuclear power because of technical uncertainties as well as expected high costs and they pleaded for renewable energy instead. Moreover, both utilities had easy access to ample domestic coal supplies and heavily invested in coal-fueled power plants. Industry only became the core proponent of nuclear energy once a knowledge base had been established through publicly funded research and a state-organized infrastructure had emerged. After 1955, when the Allied restriction on nuclear research and development in Germany came to an end, a series of research establishments was founded, with the large-scale facilities in Karlsruhe (Baden-Wuerttemberg) and Jülich (North Rhine-Westphalia) centre-stage. The first nuclear power plant went online about ten years later, in 1961, which launched nuclear power as an industrial business in West Germany. While supporters of the research facilities in Karlsruhe envisioned that the centre would spur the creation of no less than 100,000 new jobs, critical voices for instance from local women's associations opposed the center's urban setting and pointed at the danger posed to citizens in a city with a high population density.

In Sweden too, an ambitious research programme on nuclear energy was launched, pursuing both civilian and military goals. In order to be able to build nuclear weapons, a nuclear fuel cycle based on heavy-water reactors was resolved in the mid-1950s. The programme involved two phases: first, the building of several research and experimental reactors, and secondly, the construction of commercial reactors. The military use of nuclear power in particular was contested, and growing factions within the governing Social Democratic Party, especially it's Women's Association, wanted to put a halt to the development of nuclear weapons. Thus, similar to German women's associations, Swedish women were also criticizing nuclear power in the 1950s, which indicates a transnational phenomenon even if the focus was still on local developments.

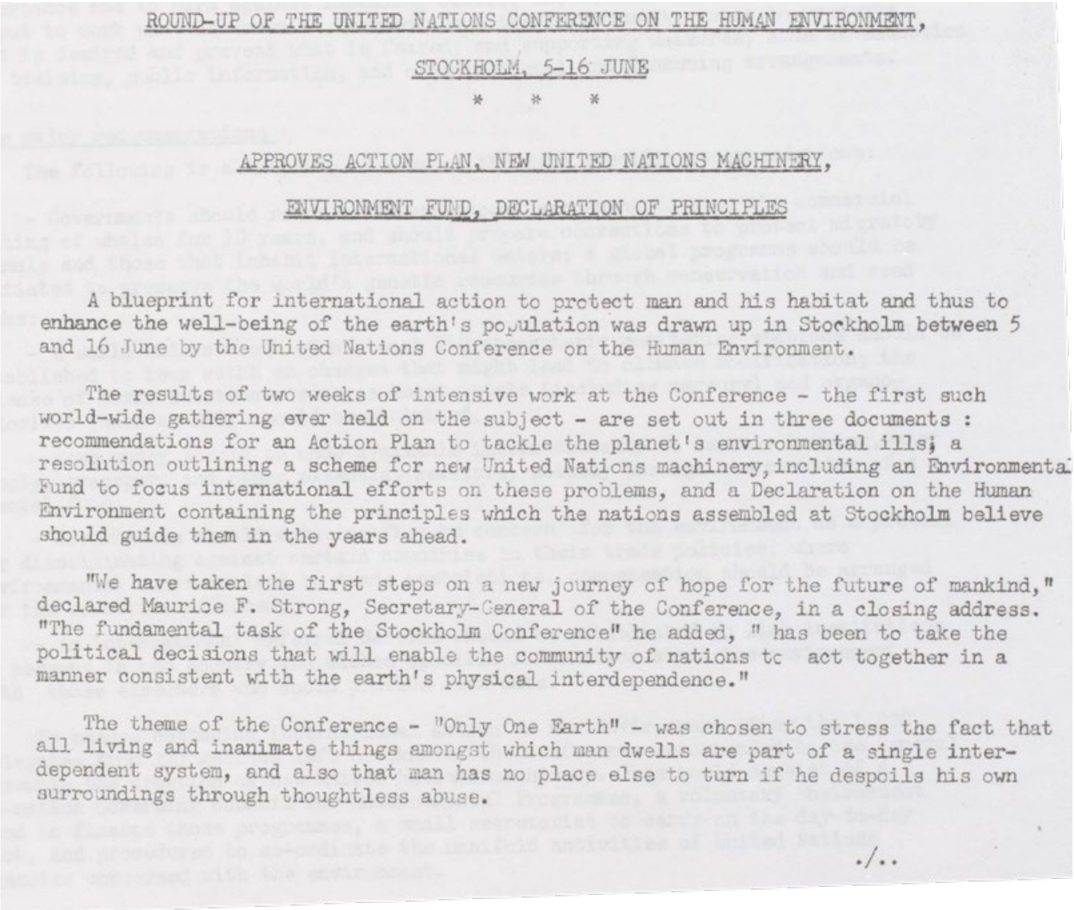
Anti-nuclear protest that went beyond local concerns – first from national perspectives, and then also in global terms, involving transnational exchange and declarations of solidarity between people of different countries – only prevailed from the mid-1970s onwards. Nevertheless, these developments had their beginnings in the 1960s, when political events paved the path for a more globalized notion of common responsibility that became powerful in the 1970s and in later decades. In the beginning of the 1960s, the American biologist Rachel Carson published the non-fiction bestseller *Silent Spring*, which is regarded as the point of departure of the worldwide environmental movement (Griswold 2012). It became clear in the 1960s that many countries were simultaneously formulating similar concerns, above all with regard to local environmental problems (Kriesi et al. 1995, 112). Moreover, publications like the report *The Limits to Growth* of the Club of Rome (a non-commercial organization founded in 1968 that wanted to stimulate a worldwide exchange of ideas on the major problems of the world) were widely read, but also heavily criticized.[12] The futurologists of the Club of Rome brought the dangerous effects of the ways humans were using nature on the living conditions of humankind to the foreground. They raised awareness of the fact that the resources of "spaceship Earth" and its "ecological sustainability" were limited, chiefly by postulating a connection between environmental crisis and population growth (Höhler 2015). Due to these developments, the central focus of environmental movements in many industrialized countries gradually shifted from traditional conservation to questions of ecology. Thus, for the first time, human needs in relation to nature and the "rationel," that is to say sustainable, use of global resources became a guiding principle for environmental concerns (Hünemörder 2004, specially from p. 114 onward).

The 1970, 80s, and beyond

The dawn of the 1970s, when the post-war boom came to an end and Western societies experienced dramatic change, meant a crucial rupture in the history of nuclear Europe as well. The Strasbourg-based Council of Europe declared 1970 to be the "European Conservation Year" and two years later the world's first Green Party was founded in Australia (the United Tasmania Group) (Meyer 2017a, 50–53). In the same year, 1972, in Stockholm, the United Nations Conference on the Human Environment was held and created the UN Environment Programme. In the aftermath of this, the European Council adopted its first five-year programme on the environment which centred on the idea that prevention is better than cure (Dodds 2012, 15 et seq., Meyer 2017b, 185–190).

Activists, experts, environmental and anti-nuclear movements began to build transnational networks (Kirchhof, and Meyer 2014). A significant transfer of ideas took place, which in some cases resulted in collaborations. A crucial factor was distance. For instance, where nuclear reactors were built close to two or sometimes three different countries, people of diverse nationalities usually had similar interests. Furthermore, since the travel distances were rather minimal, it was easier to join and support local protests. Collaboration on a broader scale seemed more difficult. Despite common ideologies and views, each movement had a different

12 A recent overview of the controversy on *The Limits to Growth* can be found here: Nørgård, Peet, and Ragnarsdóttir 2010.



ROUND-UP OF THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT,

STOCKHOLM, 5-16 JUNE

* * *

APPROVES ACTION PLAN, NEW UNITED NATIONS MACHINERY,

ENVIRONMENT FUND, DECLARATION OF PRINCIPLES

A blueprint for international action to protect man and his habitat and thus to enhance the well-being of the earth's population was drawn up in Stockholm between 5 and 16 June by the United Nations Conference on the Human Environment.

The results of two weeks of intensive work at the Conference - the first such world-wide gathering ever held on the subject - are set out in three documents : recommendations for an Action Plan to tackle the planet's environmental ills; a resolution outlining a scheme for new United Nations machinery, including an Environmental Fund to focus international efforts on these problems, and a Declaration on the Human Environment containing the principles which the nations assembled at Stockholm believe should guide them in the years ahead.

"We have taken the first steps on a new journey of hope for the future of mankind," declared Maurice F. Strong, Secretary-General of the Conference, in a closing address. "The fundamental task of the Stockholm Conference" he added, " has been to take the political decisions that will enable the community of nations to act together in a manner consistent with the earth's physical interdependence."

The theme of the Conference - "Only One Earth" - was chosen to stress the fact that all living and inanimate things amongst which man dwells are part of a single inter-dependent system, and also that man has no place else to turn if he despoils his own surroundings through thoughtless abuse.

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Figure 4 Excerpt of the press release after the United Nations Conference of the Human Environment in Stockholm, 19 June 1972. Source: Library of Congress, Russel Train Box 15, Folder 5, Government File.

focus, different strategies, different cooperative cultures, and travel distances, as well as costs, made inter- and transnational collaboration often impossible (Kirchhof 2014, Tompkins 2016a, esp. 131 et seq., Kirchhof and McConville 2015).

Women were frequently at the forefront among critical citizens. A school of thought called 'difference theory' highlighted the differences between the sexes in how they approach(ed) the world, and therefore in their dealings with nuclear issues, and many women founded new initiatives, informed themselves and others about the risks involved in the civilian and military use of nuclear power, published leaflets, gave speeches, and organized conferences. The term 'difference feminism' developed in American feminism in the 1980s. Difference feminism theory constructed biological and/or cultural differences between men and women and insisted that simultaneously equal rights still applied for both sexes. Thus, it was developed in order to claim equal treatment for women. While liberal feminism aimed to make society and law gender-neutral – seeing gender difference as a barrier to rights and participation within liberal democracy – difference feminism argued that gender-neutrality harmed women because women were either impelled to imitate men, or they deprived society by their distinctive contributions, or because women could only participate in society on a men favouring ground.

Within the ecofeminism school of thought, positions based on difference feminism theory emerged presuming that women's reproductive abilities bond them more closely to nature, which assigned women an important role in the process of ecological regeneration. An understanding of gender was developed, which criticised one-dimensional rationality and pleaded for the inclusion of the body. The aim was to create a holistic world view and return intuition, emotion and spirituality to the previously disembodied subject.

The theory was historically important but subsequently fell out of use, especially in academia, although in societal debates and partly also in biological research the argument about the existence of biological differences between the sexes can still (widely) be found (Gilligan 1982, Flaake 2005, Kirchhof 2015).

The case studies of the HoNESt project including the five countries in this volume reveal that public acceptance of and opposition to nuclear technologies are the result of an interplay among numerous factors influencing and shaping perceptions and values. These factors include levels of knowledge, familiarity, voluntariness, perceived risks and benefits, institutional trust, procedural fairness, risk tolerability, and availability of scientific information reflecting a broad spectrum of interactions between people and institutions within local communities and within wider society (Poortinga, Pidgeon and Lorenzoni 2005; Pidgeon, Lorenzoni and Poortinga 2008; Parkhill et al. 2010, Besley 2012, Visschers and

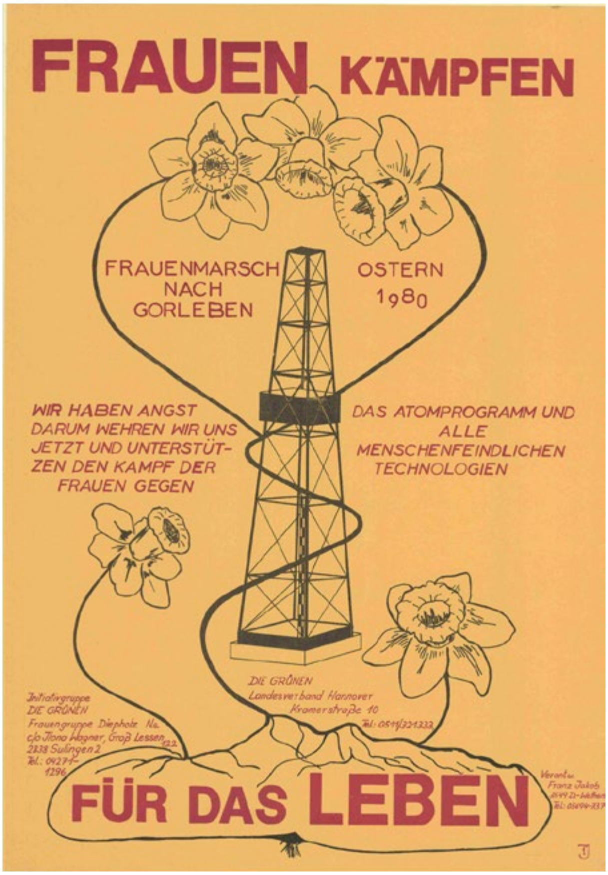

Figure 5 Poster "Women fight for life" by the women's group Diepholz of the Greens in Lower-Saxony which calls for a women's march to Gorleben at Easter 1980. The text says: "We are afraid and hence now oppose by supporting the women's fight against the atomic programme and all misanthropic technologies".

Siegrist 2012, Whitton et al. 2016). The investigation shows that the types of perceived risks and benefits are very similar across countries (basically concerned with health and safety, environmental and economic issues), and that their evolution over time displays very similar patterns. Despite these similarities between countries, public acceptance of nuclear energy is quite different in each country. This evidence suggests that additional variables need to be taken into consideration, such as those related to trust, to understand how people perceive their relationship with institutions and the State as well as companies, also socio-cultural and historical factors shaping the context in which risks and benefits are perceived. For instance, economic reasons such as job security and self-sufficiency (not relying on energy resources from other countries) were strong arguments in support of nuclear energy. Almost all political parties were pro-nuclear in the early postwar period. Many politicians of the countries analyzed in this volume changed sides eventually, e.g. to keep voters. Another reason is that the international environmental and anti-nuclear movement, as well as other social movements, had raised awareness about the risks nuclear energy involved. Social movements and their activities contributed to altering society's value system, reinforcing democratic engagement with techno-political decisions (Milder 2015, Milder 2017). Additionally, accidents like those at Three Mile Island, Chernobyl, and Fukushima strengthened anti-nuclear movements worldwide and highlighted to the public the risk of high consequence which changed attitudes (Keller, Visschers and Siegrist 2012). Society was also informed by studies on health effects on people living near nuclear facilities and possible release of radioactivity (Keller, Visschers and Siegrist 2012; Kılınç, Boyes, and Stanisstreet 2013). Siting decisions can be important obstacles to nuclear development in many countries, too (Cotton 2017), as was the case in Germany, but also can lead to competition for economic reasons like in Sweden. Some authors also highlighted public conceptions of nuclear energy in terms of military applications. Citizens expressed fear of risks resulting from the proliferation of nuclear weapon technologies such as uranium enrichment facilities (Keller, Visschers and Siegrist 2012, Lehtveer and Hedenus 2015). Opposition to nuclear energy was also due to how open or closed political systems were to the input or critique by societal actors, drawing on the distinction introduced by contemporary social scientists such as Herbert Kitschelt (Kitschelt 1986, 66). For instance, if political systems were more open, as was the case in Denmark, this invited assimilative structures, which meant anti-nuclear movement activists found access to established institutions. If a political system was more closed, as was the case in West Germany, movemen tended to be more confrontational and concentrate their action outside established structures.

We will come back to this point later. First, we will take a closer look at the decisions of the respective countries on how to proceed with nuclear energy.

By the end of the 1960s, Austrian electricity companies, together with the Conservative government under Chancellor Josef Klaus, were planning a nuclear power plant in Zwentendorf in Upper Austria.

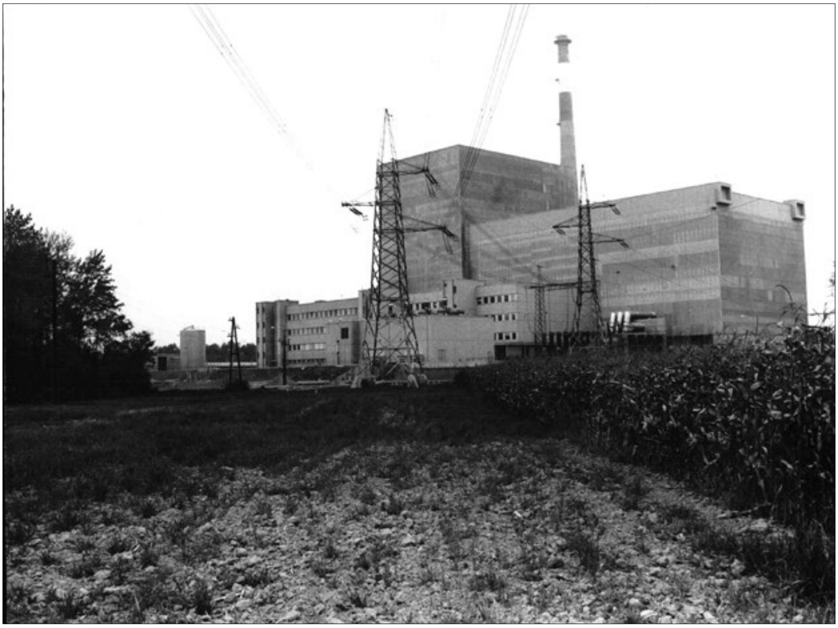

Figure 6 The nuclear power plant Zwentendorf in October 1978

The decision to build the plant was finally made in 1971 by the Social Democratic government under Chancellor Bruno Kreisky. Construction started in 1972 and two more nuclear power plants were planned to be completed within the next 20 years. In the year 1975, protests by local farmers and vintners against the construction of a nuclear power plant in the village of Wyhl in Baden, in neighbouring West Germany, had raised attention to the issue of nuclear power across borders. A year later, public debate about nuclear energy also started in Austria in 1976 and in the process its supporters and opponents were both heard (Milder 2013). The start-up of the plant in Zwentendorf was delayed and Kreisky initiated a referendum in 1978. A slight majority, 50.4 %, voted against putting the already completed nuclear power plant into operation, and thus it never went online. Shortly after the referendum, the Austrian parliament passed a law banning the use of atomic power. Following the Three Mile Island accident in 1979 and the Chernobyl accident in 1986, the Austrian anti-nuclear movement was strengthened and plans to withdraw the ban on nuclear power again were ultimately dropped.

Sweden's belief in an almost exponential future growth in energy consumption was modified in the mid-1970s and a reduction of future energy growth predicted instead. After political campaigns that went on for several months, a referendum on nuclear power took place in 1980. It asked voters to choose between three possible ways to proceed. Options 1 and 2 suggested phasing out, but only in the distant future – 58 % of all participants voted for either one or the other of these; the two possibilities only differed in the matter of whether nuclear power plants should be publicly or privately owned. Option 3 had been put forward by a mass movement of grassroots activists in the previous campaign, and supported the immediate phasing out of nuclear energy – 38.7 % of voters opted for this solution while 3.3 % were blank votes. As referenda in Sweden are only advisory, it was the task of the Social Democratic-led parliament to transform the referendum results into a political decision. It formulated a phase-out of nuclear energy in the distant future, and otherwise vaguely proposed the intention to develop an energy system on sustainable, renewable, and environmentally friendly energy sources. Unlike in Italy, the Chernobyl accident caused no fundamental rethinking of this policy, as it was argued that an immediate phase-out would have economic consequences; workers' concerns and economic reasons came into conflict with green convictions, and the phase-out of nuclear power took a back seat to national job security.

Italy too had a referendum in 1987, which was launched after the Chernobyl disaster in 1986 and started a debate about nuclear energy. Voters were asked for their consent or rejection regarding three different questions about cancelling the national nuclear energy scheme. The majority of voters approved of abandoning nuclear power. This outcome terminated the construction of a nearly completed power station and led to the closure of two other ones. Further plants that had existed in Italy had already been shut down prior to the referendum.

Denmark and Germany went down slightly different routes. The landmark event in Denmark was not a nuclear accident, but the oil crisis of 1973 which hit Denmark particularly hard, because it heavily relied on imported oil from the Middle East for its energy needs. Thus, utilities and government were keen to build nuclear power plants to diversify energy provision and reduce import dependency, and applied for licenses in early 1974. Under pressure from growing non-violent protest by the newly founded Organisation for Nuclear Information, in 1974, parliament postponed plans to grant licenses for nuclear power plants in order to provide time for public debate and reflection. Politicians, ministries, committees, protest groups, experts, and counter-experts, as well as the media, were involved in this solution-finding process, which offers a unique example of state-sponsored grassroots engagement. The process in Denmark was quite different to the Swedish situation, where an industry-sponsored campaign competed with a grassroots activist rally, instead of working together to enlighten the public. As in all other countries, the Danish Social Democrats were receptive to technology as a path to modernization and welfare, and were thus in favor of nuclear energy. The Danish Energy Debate of 1974–1976 spurred the discourse on alternatives to nuclear power and in 1979–1980, the Danish Anti-Nuclear Organization OOA distributed 2.3 million copies of a 12-page brochure informing about the possibilities of alternative energy resources. Finally, in 1985, the Danish parliament decided to exclude nuclear power from future energy planning completely. (Figure 7)

West German voters were never granted the opportunity to voice their views via a national referendum because the Basic Law rules out plebiscites. While in Germany, too, the Social Democratic Party had strongly advocated nuclear energy as a catalyst for technological and industrial modernization during the 1950s and 1960s, internal debates started in the second half of the 1970s, with many young socialists like future Chancellor Gerhard Schröder opposing nuclear energy. Once in opposition, after 1982, the party shifted to an anti-nuclear position. In 1998 – under the newly elected Social Democratic Party Chancellor Gerhard Schröder (after a conservative-liberal government under Chancellor Helmut Kohl for 16 years) – the red-green coalition decided to phase out nuclear energy within 20 years. As in the decades before, the conservative-liberal government, which was re-elected in September 2009, still supported nuclear energy and was committed to rescinding the phase-out policy. A rekindled anti- nuclear movement and especially the Fukushima Daiichi nuclear disaster in 2011 led to a rethinking of this policy.

Figure 7 The poster below speaks out for a nonnuclear Denmark and states: "This year's most important brochure: 12 pages showing that we can be better off without nuclear power in Denmark – distributed to all households in the country. OOA's People's Leaflet: Denmark without Nuclear Power. We can say 'No thanks' without lacking anything. Demand from politicians: Plan without nuclear power"

Shortly afterwards, conservative Chancellor Angela Merkel announced the closure of all German nuclear power plants by 2022.

In Sweden in 1997, one year before Germany's decision, the Social Democrats, the Left Party, and the Green Party decided to start a phase out of nuclear energy by closing the two reactors in Barsebäck, close to Copenhagen, which had been strongly contested by Denmark since the mid-1980s. In the Swedish Parliament, a

Figure 8 Poster for the second march against the Swedish Barsebäck Nuclear Power Plant "The North against Nuclear Power". Barsebäck March 10 September 1977: "No to Nuclear Power; No to the Spread of Nuclear Weapons; Yes to Sun and Wind; No to Centralisation; Yes to a Resource-saving Society" organized by Swedish, Norwegian, and Danish environmental/anti-nuclear organizations

new decision on nuclear power was made in 2010, which allowed the construction of new reactors, but no additional reactors have been built. Instead, two more reactors have been closed down for economic reasons, and two more will be closed by 2020.

Italy's path in the decades after its referendum showed some similarities to the developments in Germany. In 2008, more than 20 years after the initial referendum that resulted in the phasing out of nuclear energy, the Italian liberal-conservative government under Prime Minister Silvio Berlusconi started the nuclear debate again. As part of the so-called "nuclear renaissance" at the time the Minister of Economic Development proposed the building of ten new reactors, claiming that the outcome of the referendum in 1987 had been a mistake. After the Japanese nuclear accident in 2011, the Italian government revised its plans and put a moratorium on its scheme to revive nuclear power. In June 2011, a further referendum took place. Over 90 % of voters supported a construction ban, and since over 50 % of eligible voters took part in the poll, this outcome was binding for the Italian government.

Even though the phasing-out decision was made by the government in Germany, it was influenced by two long decades of struggles on the part of the German and international environmental, anti-nuclear, and other social movements that changed societal value systems worldwide. The reasons that drove the German movement were partly unique to the nation and its history, and partly congruent with motivations in other countries. As a result of Germany's history in the 'Third Reich', critics of nuclear energy argued that they would seek to pre-empt a situation, in which future generations would accuse them of having failed to act against the atomic industry, just like many young people around 1968 were accusing their parents of having failed to oppose the Nazis (Schüring 2015, 89 et seq.). In addition, the clashes between police forces and parts of the movement seem to have been more violent at times in Germany than in many other countries.[13] Historians have argued that a different understanding of civil disobedience and the non-existence of a Christian-informed civil rights movement could be responsible for this difference (Hughes 2014). Social scientists emphasize the country's political opportunity structures as a reason for more confrontational protests. They argue that the West German political system offered few opportunities to articulate opposition. For instance, no party adopted a clear anti-nuclear stance until the 1980s and executive agencies were inaccessible for the anti-nuclear opposition. Eventually, the anti-nuclear movement pressed for structural changes through the emerging Green party which was founded in 1980 (Kitschelt 1986, 70).

This volume shows that the types of perceived risks and benefits are very similar across countries (basically concerned with health and safety, environmental and economic issues). Their evolution over time displays very similar patterns and corresponds to research results in the wider field of nuclear energy and social

13 Violent, especially politically motivated, conflicts also arose in France, but especially in Spain in the 1970s and 1980s and involved the paramilitary organization Euskadi Ta Askatasuna (better known as ETA). The fierce disputes concerned the Lemóniz Nuclear Power Plant which faced major opposition of both, the Basque anti-nuclear movement and the armed Basque organization ETA (Mez, Schneider, and Thomas 2009, 371).

Figure 9 When the company Celler Brunnenbau wanted to start drillings for the final repository in Gorleben on 13 March 1979, they were hindered by protesters. Several hundred police officers protected the drillings and cleared the streets from those protesters. The poster shows Marianne Fritzen, the first president of the Citizen's Initiative BI Lüchow-Dannenberg, which has been in existence since 1972 and is still the most important initiative in the Gorleben area against the final repository and other nuclear facilities today. The picture for the poster was taken by the photographer Günter Zint who co-operated with the anti-nuclear movement. It shows Fritzen walking by a row of armed police men skeptically looking at them. Shortly after the picture Fritzen was arrested. Poster states: "Article 20 Basic Law: All state power emanates from the people."

movements. Opponents of nuclear power also raised a number of related concerns, like the critique of large-scale technology. Since nuclear power plants are especially expensive to build, many citizens argued that the economic losses and costs of these facilities far exceeded the benefits (Siegrist, Cvetkovich, and Roth 2000). They expressed fears of nuclear accidents releasing radioactivity, as nuclear power could never be completely safe. They uttered concerns that fissile material used in some types of nuclear reactors can also be used in nuclear weapons. They expressed worries that nuclear facilities could become targets for terrorist attacks, and thus required a security apparatus leading to the abolition of civil rights which the Austrian writer Robert Jungk characterised as the “Nuclear State” (Atomstaat) (Jungk 1977). Additionally, large parts of the population frequently mistrusted the state and/or the energy industry and argued that the atomic lobby lacked transparency as well as honesty. Many people saw a connection between the extension of atomic energy and democratic deficits. But if people concerned have trust in their state or in industry and transparent information policy is pursued, these concerns can be minimized (Ramana 2011, Caldicott 2006, Martin 2007). For example, when the Swedish Nuclear Fuel and Waste Management Company was searching for a location to build nuclear waste facilities in the 1990s, it found two municipalities that were already accustomed to nuclear facilities and trusted the nuclear industry so that no opposition emerged. Since the building of nuclear facilities secured jobs, the two municipalities even entered into a contest for providing the best site for the planned nuclear waste repository. The waste company adopted a transparent attitude with local inhabitants instead of a top down policy, as it realized that local acceptance was a crucial precondition for effective cooperation. In West Germany too, a nuclear waste repository in Gorleben, Lower Saxony, had been planned in the 1970s, but a comparable dialogue was missing, as political elites were fairly intransigent. Ever since that decision was made, a fierce struggle between politicians and police on the one side and locals and activists on the other side broke out, revealing a power struggle about better arguments and verbal abuses, investments, networks, alternative vs. nuclear energy, and the fundamental question of what constitutes a ‘good’ lifestyle and what role nature, humans, and technology play in it (Tiggemann 2004, Kirchhof 2018).

Concluding remarks

Cold War politics, like President Eisenhower's launching of the Atoms for Peace campaign in the 1950s, aimed at balancing fears of nuclear weapons with promises of peaceful uses of nuclear energy. It strongly influenced European nuclear energy politics and, as a result, nuclear research institutions and other organizations on the European level were founded to create a market for nuclear power and foster European integration via nuclear energy politics. Another external factor that influenced political decisions in European nations was nuclear accidents, like Chernobyl and Fukushima. Usually anti-nuclear movements grew stronger after an accident had happened which in turn also influenced governments' decisions. As has been shown here, the basic trends – like the pro-nuclear energy politics of the 1950s, the rise of strong anti-nuclear movements in the 1970s and 1980s, and the eventual phasing out – were consistent developments across the analyzed European countries in this volume. But political, economic, cultural, and historical differences between nation states led to a number of contrasting decisions in nuclear energy politics. In three cases, Denmark, Sweden, and West-Germany early proponents of nuclear energy came from politics and science, not the industrial sector. In Italy and Austria, industry and science formed a coalition. Politicians usually advocated nuclear energy for economic reasons and because of military interests.

All five states built research reactors in the immediate post-war period, and all but Denmark later also built commercial reactors. Austria built a commercial reactor, but it never went on the grid. Chances for societal codetermination took different forms in these countries, and the political opportunity structures – how open or closed political systems were – also seemed to matter. Three countries, Austria, Italy, and Sweden, held referendums between 1978 and 1987 about the question of whether or not the country should phase out nuclear energy. In all three countries, popular opinion was against nuclear energy, but in Sweden the government wanted to stay with nuclear energy and succeeded in convincing a slight majority to vote for this option which was then decided upon after the vote. In Germany, the Basic Law does not allow for referenda. Especially the affected people expressed most concerns about involved risks like health, safety, environmental, economic, while neither promoters nor public authorities and regulators focused much on these issues. Although perceived risks and benefits across time displays very similar patterns of perceptions across countries, public acceptance of nuclear energy is quite different in each country. The analysed countries in this volume over time all rejected nuclear energy which suggests that additional variables need to be addressed in order to understand public rejection of nuclear issues. According to the HoNESt research as a whole, the key for understanding consensus and conflicts on nuclear energy relies highly on the sphere of trust in institutions and socio-cultural contextual factors, which refers to issues of responsibility, moral judgements, principles of justice and equity, as well as accountability or legitimacy. Citizens often rejected the nuclear alliance between the political authorities, the nuclear industry, and techno-scientific experts. This distrust also led to the existence of counter experts (Augustine 2018). There is a long debate about the gap between different social groups' assessments of risk, especially between experts and lay people, a gap that can have adverse consequences in terms of acceptance of certain technologies such as the nuclear ones which is why engagement issues were at the forefront of the debate on involved institutions and industries. This includes understanding how people perceive their relationship with institutions and companies, as well as the type of socio-cultural factors shaping the social context in which the risks and benefits are perceived. For instance, informing the public in an unbiased and transparent way, as well as giving society an equal say with politics and the industrial lobby in the decision (as was the case in Denmark in the 1970s and in Sweden's debate about nuclear waste facilities in the 1990s) seems to build up trust not only in the public sphere but also in industry and politics which – in these two cases – minimized opposition and confrontation between actors. Three of the five states have already phased out nuclear energy or never decided to pursue it in the first place, and two states are still in the process of leaving a pathway of energy supply which has strongly shaped Europe's history over more than half a century.

References

Augustine, Dolores L. 2018. *Taking on Technocracy. Nuclear Power in Germany, 1945 to the Present.* New York and Oxford: Berghahn.

Bähr, Paul. 1970. „Was wird aus Euratom? Die Europäische Atomgemeinschaft in der Krisenzone." *Europa-Archiv 25,* 3:81–90.

Besley, John C. "Does fairness matter in the context of anger about nuclear energy decision making." *Risk Analysis* 32:25–38.

Bud, Robert and Helmuth Trischler. 2018. "Public Technology: Nuclear Energy in Europe." *History and Technology* 34 (4):187–212.

Caldicott, Helen. 2006. *Nuclear Power is Not the Answer to Global Warming or Anything Else.* Melbourne: Melbourne Univ. Press.

Cenevska, Ilina. 2016. *The European Atomic Energy Community in the European Union Context. The "Outsider" within.* Leiden and Boston: Brill, 2016.

Cotton, Matthew. 2017. *Nuclear Waste Politics: An Incrementalist Perspective.* London: Routledge.

Dodds, Felix, Michael Strauss, and Maurice F. Strong. 2012. *Only One Earth: The Long Road Via Rio to Sustainable Development.* London: Routledge.

Eckert, Michael. 1987. „'Atoms for Peace' – eine Waffe im Kalten Krieg." *Bild der Wissenschaft* 5:64–74.

Flaake, Karin. 2005. „Carol Gilligan. Die andere Stimme." In *Schlüsselwerke der Geschlechterforschung,* ed. by Martina Löw and Bettina Mathes, 158–175. Wiesbaden: VS Verlag für Sozialwissenschaften.

Gilligan, Carol. 1982. *In a Different Voice. Psychological Theory and Women's Development.* Cambridge: Harvard University Press.

Griswold, Eliza. "How 'Silent Spring' Ignited the Environmental Movement." *New York Times,* 21 September 2012, see https://www.nytimes.com/2012/09/23/magazine/how-silent-spring-ignited-the-environmental-movement.html, accessed 17 July 2018.

Guzzetti, Luca. 1995. *A Brief History of European Research Policy* (European Commission Science Research and Development Studies 5). Luxembourg: Office for Official Publications of the European Communities.

Höhler, Sabine. 2015. *Spaceship Earth in the Environmental Age, 1960–1990.* London: Pickering & Chatto Publishers.

Hughes, Michael L. 2014. "Civil Disobedience in Transnational Perspective: American and West German Anti-Nuclear-Power Protesters, 1975–1982." *Historical Social Research* 39 (4):236–253.

Hünemörder, Kai. 2004. *Die Frühgeschichte der globalen Umweltkrise und die Formierung der deutschen Umweltpolitik* (1950–1973). Freiburg: Steiner Publishing.

Jungk, Robert. 1977. *Der Atomstaat. Vom Fortschritt in die Unmenschlichkeit.* Munich: Kindler.

Keller, Carmen, Viviane H. Visschers, and Michael Siegrist. 2012. "Affective imagery and acceptance of replacing nuclear power plants." *Risk Analysis* 32 (3):464–477.

Kılınç, Ahmet, Eddie Boyes, and Martin Stanisstreet. 2013. "Exploring students' ideas about risks and benefits of nuclear power using risk perception theories." *Journal of Science, Education and Technology* 22 (3):252–266.

Kirchhof, Astrid Mignon. 2014. "Spanning the Globe: Australian Protest against Uranium Mining and their West-German Supporters." *Historical Social Research* 39 (1):254–273.

——. 2015. "Finding Common Ground in the Transnational Peace Movements." *Australian Journal of Politics and History* 61 (3):432–449.

——. 2018. "East-West German Transborder Entanglements through the Nuclear Waste Sites in Gorleben and Morsleben." *Journal for the History of Environment and Society* 3:145–178.

Kirchhof, Astrid Mignon and Jan-Henrik Meyer, eds. 2014. "Global Protest against Nuclear Power. Transfer and Transnational Exchange in the 1970s and 1980s." *Historical Social Research* 39 (1).

Kirchhof, Astrid Mignon and Chris McConville. 2015. "Introduction: Transcontinental and Transnational Links in Social Movements and Environmental Policies in the 20th Century." *Australian Journal of Politics and History* 61 (3):331–338.

Kitschelt, Herbert P. 1986. "Political Opportunity Structures and Political Protest: Anti-Nuclear Movements in Four Democracies." *British Journal of Political Science* 16 (1):57–85.

Kohlrausch, Martin, and Helmuth Trischler. 2014. *Building Europe on Expertise. Innovators, Organizers, Networkers.* London: Palgrave Macmillan, 2014, 217–229.

Kriesi, Hanspeter, Ruud Koopmans, Jan W. Duyvendak, and Marco G. Giugni. 1995. *New Social Movements in Western Europe: A Comparative Analysis* (Series: Social Movements, Protest, and Contention, vol. 5). Minneapolis: Univ. of Minnesota Press.

Krige, John. 2006. "Atoms for Peace, Scientific Internationalism, and Scientific Intelligence". In *Global Power Knowledge. Science and Technology in International Affairs,* ed. by John Krige and Kai-Henrik Barth, 161–181 (= Osiris, Second Series, 21).

——. 2008. "The Peaceful Atom as Political Weapon: Euratom and American Foreign Policy in the Late 1950s." *Historical Studies in the Natural Sciences* 38 (1):5–44.

Lehtveer, Mariliis, and Frederik Hedenus. 2015. "Nuclear power as a climate mitigation strategy – technology and proliferation risk." *Journal of Risk Research* 18 (3):273–290.

Martin, Brian. 2007. "Opposing nuclear power: past and present." *Social Alternatives* 26 (2):43–47.

Merritt, Anna J., and Richard L. Merritt. 1980. *Public Opinion in Semisovereign Germany. The HI-COG Surveys,* 1949–1955. Urbana: University of Illinois Press.

Meyer, Jan-Henrik. 2014. "Where do we go from Wyhl?" Transnational Anti-Nuclear Protest targeting European and International Organizations in the 1970s. *Social Historical Research* 39 (1):212–235.

——. 2017a. "From Nature to Environment: International Organizations and Environmental Protection before Stockholm." In *International Organizations and Environmental Protection. Conservation and Globalization in the Twentieth Century,* ed. by Wolfram Kaiser and Jan-Henrik Meyer, 31–73. New York: Berghahn.

——. 2017b. "Making the Polluter Pay: How the European Communities Established Environmental Protection." In *International Organizations and Environmental Protection. Conservation and Globalization in the Twentieth Century,* ed. by Wolfram Kaiser and Jan-Henrik Meyer, 182–210. New York: Berghahn.

Mez, Lutz, Mycle Schneider and Steve Thomas, eds. 2009. *International Perspectives of Energy Policy and the Role of Nuclear Power.* Brentwood, Essex: Multi-Science Publishing Co.

Milder, Stephen. 2010. "Thinking Globally, Acting (Trans-)Locally: Petra Kelly and the Transnational Roots of West German Green Politics." *Central European History* 43 (2):301–326.

——. "The New Watch on the Rhine: Anti-Nuclear Protest in Baden and Alsace." Environment & Society Portal. *Arcadia* no 6, see https://doi.org/10.5282/rcc/5257, accessed 12 July 2018.

——. 2015. "Between Grassroots Protest and Green Politics: The Democratic Potential of the 1970s Antinuclear Activism." *German Politics & Society* 33 (4):25–39.

——. 2017. *Greening Democracy. The Anti-Nuclear Movement and Political Environmentalism in West Germany and Beyond,* 1968–1983. Cambridge: Cambridge University Press.

Nash, Philip. 2017. "Eisenhower, Nuclear Weapons, and Arms Control." In *A companion to Dwight D. Eisenhower,* ed. by Chester J. Pach, 327–349. Oxford: John Wiley & Sons, 2017.

Nehring, Holger. 2005. "National Internationalists: British and West German Protests against Nuclear Weapons, the Politics of Transnational Communications and the Social History of the Cold War, 1957–1964." *Contemporary European History* 14 (4):559–852.

Nørgård, Jørgen S., John Peet, and Kristín V. Ragnarsdóttir. 2010."The History of the Limits to Growth." The *Solutions Journal* 1 (2):59–63.

Paoloni, Giovanni. 1994. "Gli esordi del nucleare italiano." In *Storia dell'industria elettrica, vol. 4: Dal dopoguerra alla nazionalizzazione 1945–1962*, ed. by Valerio Castronovo, 383–408. Rome-Bari: Laterza.

——. 2009. *Il nucleare in Italia. Nuclear Power in Italy, Archivio storico ENEL. Rome: Archivio storico ENEL.*

Parkhill, Karen A. et al. 2010. "From the familiar to the extraordinary: local residents' perceptions of risk when living with nuclear power in the UK." In *Transactions of the Institute of British Geographers* 35:39–58.

Pidgeon, Nick F., Irene Lorenzoni, and Wouter Poortinga. 2008. "Climate change or nuclear power – No thanks! A quantitative study of public perceptions and risk framing in Britain." *Global Environmental Change* 18 (1):69–85.

Poortinga, Wouter, Nick F. Pidgeon, and Irene Lorenzoni. 2006. *Public perceptions of nuclear power, climate change and energy options in Britain: summary findings of a survey conducted during October and November 2005. Understanding Risk Working Paper 06-02,* https://sp.ukdataservice.ac.uk/doc/5357/mrdoc/pdf/5357userguide.pdf, accessed 24 April 2019.

Preda, Daniela, and Daniele Pasquinucci, eds. 2010. The Road Europe Travelled Along: *The Evolution of the EEC/EU Institutions and Policies.* Brussels: Peter Lang.

Ramana, M. V. 2011. "Nuclear power and the public." *Bulletin of the Atomic Scientists* 67 (4):43–51.

Renn, Ortwin. 1995. "Perzeption: 'Akzeptanz und Akzeptabilität der Kernenergie'." In *Handbuch Kernenergie: Kompendium der Energiewirtschaft und Energiepolitik*, ed. by Hans Michaelis and Carsten Salander, 762–776. Frankfurt: VWEW Verlag.

Rosamond, Ben. 2000. *Theories of European Integration.* Basingstoke and New York: Palgrave Macmillan.

Schüring, Michael. 2015. *'Bekennen gegen den Atomstaat'. Die evangelischen Kirchen in der Bundesrepublik Deutschland und die Konflikte um die Atomenergie 1970–1990.* Göttingen: Wallstein Verlag.

Siegrist, Michael, George Cvetkovich, and Claudia Roth. 2000. "Salient value similarity, social trust, and risk/benefit perception." *Risk analysis* 20 (3):353–362.

Skogmar, Gunnar. 2004. *The United States and the Nuclear Dimension of European Integration.* Basingstoke and New York: Palgrave Macmillan.

Tiggemann, Anselm. 2004. *Die 'Achillesferse' der Kernenergie in der Bundesrepublik Deutschland: Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985.* Lauf an der Pegnitz: Europaforum-Verlag.

Tompkins, Andrew. 2016a "Grassroots Transnationalism(s): Franco-German Opposition to Nuclear Energy in the 1970s." *Contemporary European History* 25 (1):117–142.

——. 2016b. *Better Active than Radioactive! Anti-Nuclear Protest in 1970s France and West Germany.* Oxford: Oxford University Press.

Visschers, Viviane H. and Michael Siegrist. 2012. "Fair play in energy policy decisions: Procedural fairness, outcome fairness and acceptance of the decision to rebuild nuclear power plants." *Energy Policy* 46:292–300.

White, Richard. 1999. "The Nationalization of Nature." *Journal of American History* 86 (3):976–986.

Whitton, John et al. 2016. *Theoretical, Methodological and Epistemological Challenges of the Multi–disciplinary.* History of Nuclear Energy and Society (HoNESt) Research Project. Paper presented at ESSHC 2016, Valencia.

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The Failure of Nuclear Energy in Austria: Austria's Nuclear Energy Programmes in Historical Perspective

Executive Summary

Today Austria is better known for its tradition of hydropower and "green" energy production than for the implementation of nuclear energy. For instance, the completion of the large-scale project of the Alpine hydropower plant in Kaprun in 1955 against the objections of the Allied Forces after World War II became one of the founding myths of the second Austrian Republic. The construction of the hydropower plant started shortly after the Nazis had seized power in Austria but could not be finished before the end of WWII and was then resumed. Likewise, many Austrian physicists were engaged in the first Austrian attempt to establish nuclear energy after the annexation by Germany in the German nuclear weapons project (Uranverein) after 1941. This Austrian-German cooperation and therefore the whole programme failed with the defeat of the German Reich and its Allies in 1945. After the war Austria was divided like Germany into four occupation zones. Despite this, the idea of generating energy from nuclear fission was still present in Austria's post-war politics. However, lack of sufficient funds prevented the development of a national nuclear energy programme. This situation changed after the launch of Atoms for Peace with Eisenhower's famous speech in December 1953. Immediately after Austria regained its national sovereignty in March 1955, the Austrian Council of Ministers decided to build a research reactor with American support. Knowledge transfer from the USA was crucial for Austria's plans. Industry and utilities, academia, and government struggled for the leadership in the process of implementation of this knowledge. Industry and government collaborated leading to the founding of the Austrian Research Centre for the Peaceful Use of Nuclear Energy in Seibersdorf. Austrian universities received their own TRIGA reactor from the USA, located in Vienna. This corresponds to Austria's second attempt to implement nuclear energy, specifically, nuclear energy research. In the course of this attempt, three research reactors were brought into service with the aim of developing a nuclear energy production programme in Austria. This third attempt resulted in the decision of the Austrian government under Chancellor Bruno Kreisky in 1971 to build a nuclear power plant near Zwentendorf in Lower

Austria. At the beginning of that decade local anti-nuclear protest groups emerged which remained ignored before forming a broad national movement. These increasingly public concerns led the Austrian Chancellor Bruno Kreisky to call for a referendum in mid-1978, which resulted in stopping the power plant at Zwentendorf before it went critical.

Contextual Narrative

The beginning of the Austrian programme

In contrast with the dominant German role in the Uranverein, the Austrian contribution has attracted only little attention. It was Austria's first attempt to acquire nuclear energy. Therefore, a brief sketch of the Austrian activities will be given here (Fengler 2014; Fengler and Forstner 2008; Fengler and Sachse 2012).

In the early 20th century two centres of nuclear research existed in Vienna. One was located at the Second Institute for Physics of Vienna University and the other at the Institute for Radium Research of the Austrian Academy of Science. The Radium Institute was opened in 1910 and became (due to Austria's monopoly on pitchblende, the raw material for radium production) one of the major centres of the international network of the so-called "radium-activists". One astonishing feature of the Institute at that time was the high percentage of female staff, which the historian Maria Rentetzi traced back to the social and political milieu of the "Red Vienna" of the 1920s and 1930s (Rentetzi 2004a).

After the *Anschluss* (annexation) of Austria to Germany in 1938 about a fourth of all Austrian nuclear researchers lost their jobs, principally due to anti-Jewish sanctions, and the number of women, which were employed at the Radium Institute plummeted by half within the course of a year. Two positions for full professors and two for associate professors at the physics departments of University of Vienna were subsequently filled by the appointment of National Socialist scientists or opportunistic fellow travellers. These individuals assured themselves of the support of the Third Reich, and then proceeded to reorganize nuclear research in Vienna: the Second Institute for Physics and parts of the Institute for Radium Research were merged, creating the Four Year Plan Institute for Neutron Research in 1943 (Reiter 2004a; Reiter 2004b; Reiter 2001a).

Already before the founding of the Four Year Plan Institute the discovery of nuclear fission attracted the interest of Austrian physicists and the German Uranverein opened new possibilities for their research, which were embraced by the

Austrians. The Austrian research carried out in the Uranverein had mainly the character of fundamental research, sometimes specifying the Uranmaschine (uranium nuclear reactor) as the aspired application.[1] Scattering cross sections of neutrons in uranium and the increase of neutrons in fission reactions were a central topic of the investigations. For this analysis spherical symmetric geometries with layers of paraffin and uranium were used in the experiments. Also (n, 2n)-processes in lead were analysed.[2] It can be noted that, later in the post-war era, the same experimental setups and geometries were used, e.g. in the habilitation of Karl Lintner (Lintner 1949), the assistant of Georg Stetter during the war. However, besides all kinds of fundamental research, building a nuclear reactor was the core aim behind the Austrian nuclear activities as the application for a patent for a reactor from Georg Stetter, the head of the Four Year Plan Institute, shows.[3] This thesis is supported by a statement at the end of a report about the engagement of the Second Physical Institute of the University of Vienna in the German Uranverein where the authors claim that, for a continuation of large-scale experiments for the uranium machine, about two tons of uranium metal, one ton of paraffin and possibly 500 kg heavy water were needed.[4]

At the end of WWII large parts of the equipment and staff were transferred to the Western zones of the Allied-occupied Austria to protect them from bombings and, presumably, from the Soviet troops. The reasons for the failure of this programme are well known (Walker 1989; Walker 2007, Forstner, 2019): in comparison to other war projects the priority level of the nuclear energy programme

1 In the course of the American ALSOS mission the reports of the Uranverein were confiscated and transferred to the United States. Today the "G-reports" are disclosed for research in the Archives of the Deutsches Museum in Munich (DMA) and enlighten the Austrian role in the Uranverein. Josef Schintlmeister, „Die Aussichten für eine Energieerzeugung durch Kernspaltung des 1,8 cm Alphastrahlers," Report from 26 February1942, DMA FA 002 / Vorl. Nr. 0159, and Willibald Jentschke and Karl Kaindl, „Vorläufige Mitteilung über die Abhängigkeit der Größe der Resonanzabsorption bei verschiedenen Temperaturen," Report from 5 September 1944, DMA FA 002 / Vorl. Nr. 0212, as well as „Bericht über die Tätigkeit des II. Physikalischen Institutes der Wiener Universität und des Institutes für Radiumforschung der Wiener Akademie der Wissenschaften," Report from July 1945, DMA FA 002 / Vorl. Nr. 0719.

2 Georg Stetter and Karl Lintner, „Schnelle Neutronen in Uran (I): Der Zuwachs durch den Spaltprozess und der Abfall durch unelastische Streuung", „Schnelle Neutronen in Uran (II): Genaue Bestimmung des unelastischen Streuquerschnittes und der Neutronenzahl bei 'schneller Spaltung', „Schnelle Neutronen in Uran (III): Streuversuche", Reports from September 1942, as well as Georg Stetter and Karl Kaindl „Schnelle Neutronen in Uran (VI): Der (n,2n)-Prozess in Blei und die Deutung der Vermehrung schneller Neutronen in Uran," no date, presumably end 1942, DMA FA 002 / Vorl. Nr. 0743, 162, 163, 240, 243.

3 Patent application of Georg Stetter at the Reichspatentamt 14 June 1939, estate Georg Stetter, Special Collection of the Austrian Central Library for Physics, Vienna. After the war Stetter made demands because of his patent application, however they were denied in the lawsuit. See also Archive of the Austrian Academy of Sciences, 1010 Vienna, Collection of the Institute for Radium Research, box 55, fiche 812.

4 G-Report 345, p. 23, DMA FA 002 / Vorl. Nr. 0705.

was low and at the end of the war the lack of resources led to important delays. For example, in November 1940 the Austrian Academy of Science decided to build a neutron generator for the Radium Institute. The generator was ordered in 1941 with a delivery period of 36 months. In June 1942 a new priority level was granted and the delivery time was reduced to 22 months. Delivery problems from German suppliers delayed the project again and again. Finally, the City of Vienna refused the building license for the necessary modification of the Institute building. Therefore, at the end of 1944 a new place for the generator had to be found. In March 1945 a gym in Krems, a city about 60 km to the west of Vienna, was chosen as the new location for the neutron generator. However, the liberation by the Allied forces ended all plans installing the generator and stopped other parts of Austria's first attempt to develop nuclear energy.[5]

Another often overlooked chapter of Austria's nuclear history concerns the production of heavy water. In 1950 Colonel Gousset, a member of the French forces in Tyrol, asked the theoretical physicist Ferdinand Cap from Innsbruck University for his expertise concerning the production of heavy water in Tyrol during the war. In his report Cap described an "apparatus" for the production of heavy water on the basis of electrolytic separation similar to the method of Norsk-Hydro A.G. in Norway. Furthermore, he mentioned test plants for the production of heavy water in Tyrol that were built during the war. From the report it seems that these test plants never reached the level of a large-scale production. However, as Professor Cap, who provided the report to the author, stated that all production facilities were destroyed by the French forces and no further evidence for the existence of the production of heavy water in Tyrol could be found.[6]

Liberation, reorganization and reconstruction

The efforts that were made after the liberation by the Allied forces in 1945 can be described best as "back to 1938" before the *Anschluss* – not to mention that there was an authoritarian state with political repression in Austria from 1934 onwards. These efforts regarded personnel changes in the course of "denazification" and changes in the structure and organization of research. One of the first tasks was the dissolution of the Four Year Plan Institute for Neutron Research and the restoration of the former organization of the university and academy institutes. In the course of the "denazification", former members of the National Socialist Party

5 Correspondence of Gustav Ortner with the Helmholtz-Gesellschaft, Düsseldorf, the C.H.F. Müller AG, Hamburg, and the Reichsamt für Wirtschaftsaufbau in Berlin (1940–1945), Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 32, fiche 444–447.

6 Report of Ferdinand Cap for Colonel Gousset about a plant for the production of heavy water in Tyrol, 24 November 1950. Copy in the archive of the author, kindly left by Professor Dr Ferdinand Cap. Interview with Ferdinand Cap conducted by the author, Innsbruck, 3 August 2007. Archive of the author.

were removed from the institutes, among them Georg Stetter, the head of the Second Institute for Physics, and Gustav Ortner, the head of the Radium Institute, who both got their jobs after 1938 because of the anti-Jewish measures of the Nazis. At the same time, some of the forced Austrian emigrants from WWII were invited to come back. Stefan Meyer, the former head of the Radium Institute before 1938, was appointed as director of the institute again, while Berta Karlik became the managing director of the institute (Reiter and Schurawitzki 2005). In 1947 Stefan Meyer retired and Berta Karlik was appointed as new director, which also marked the beginning of a new era for the institute. She had finished her PhD at the University of Vienna in 1928, started her research at the Radium Institute in 1928/29 and became a graduate assistant in 1933. In the intervening time she studied a year under William Bragg at the Royal Institution in London with the help of a fellowship of the International Federation of University Women from November 1930 to December 1931. In 1935 she was invited to Sweden for several months to undertake research. After finishing her habilitation, the University of Vienna awarded her the *venia legendi* in 1937. She received several fellowships until she was appointed as lecturer with remuneration (Dozentin mit Diäten) in 1942. She never took part in the research programme of the German Uranverein and tried to develop her own line of research within the institute. It was not clear at all whether she could continue her work after the Nazis had seized power in Austria. Her request for an extension of her fellowship was denied by the German watch-dog for the Viennese University (Kurator der wissenschaftlichen Hochschulen in Wien) with the argument, that there were no chances for females in academia. Thanks to an intervention of the Director of the institute Gustav Ortner, it was made possible for her to stay at the Radium Institute with regular benefits. In a report of the NS-Dozentenführer (Leader of the NS organization for university lecturers) she is described as non-politicised. All in all, it seems that she tried to find her own scientific way without attracting any political attention – neither positive nor negative for the NS-government.[7] Her unobtrusive behaviour during the NS-era made her post-war career possible.

In contrast to the situation in Germany, there seemed to have been no formal restrictions for nuclear research in Austria after the Liberation in 1945. Moreover the Allied and, in the first instance, the American troops supported the Austrian scientists in the reorganization of their research facilities especially in safe transport of the radium standard compounds and instruments, that were stored in the Western zones of Austria at the end of the war.[8] Contemporary witnesses, like Karl

7 Archive of the University Vienna, Vienna, personnel file Berta Karlik, file no. 2152.

8 Adrienne Janisch: „Wie das Radium nach Wien zurückkam. Ein zehn-Tonnen Lastkraftwagen war zum Transport von zwei Gramm nötig" (Radio Vienna, 18 May 1946), Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 8, fiche 138. See also the correspondence between Berta Karlik and the Allied forces, box 55, fiche 812.

Lintner, who was the assistant of Stetter during the war, do not remember any restrictions for nuclear research, e.g. Lintner finished his habilitation thesis in 1949 on the interaction of fast neutrons with the heaviest stable nuclei (Hg, Tl, Bi and Pb) (Lintner 1949). His post-war research was mainly based on the work that was carried out in the German Uranverein.[9] Prof. Cap does not recall restrictions either.[10] The testimonials of the contemporary witnesses are supported by the documents found in the Archive of the Austrian Academy of Science. For example, in 1947 Berta Karlik asked the German contractor of the above-mentioned neutron generator to fulfil their commitments and deliver the generator. However, this request was denied due to the restrictions for nuclear research in Germany and some parts of the equipment had already been dissembled and confiscated by the Allied forces.[11] In 1966 Karlik offered 400 kg of pure uranium nitrate for sale, which was owned by the Radium Institute since the war and was at that time supplied by the Germans for the extraction of uranium isotopes.[12] Considering all these aspects it seems plausible that there were no legal restrictions for nuclear research in Austria after the war.

While the reconstruction of the Radium Institute was still in progress the reappointed Director Stefan Meyer started to reactivate his old networks from the pre-war era. The Radium Institute in Vienna was, in addition to Paris, the second depository of a primary radium standard and Stefan Meyer was elected as secretary of the International Radium Standard Committee after its foundation in 1910 and later as its president (Reiter 2001b, 113–14). Whereas networks are based on mutual confidence and trust in the competence, professional skills, methods and reliability of each member, measurements and a publication of a member of the German Physikalisch-Technische Reichsanstalt in Berlin seemed to challenge the exactness of the Austrian radium standard and the competence of the members of the Radium Institute.[13] Therefore Meyer's first task was to restore the reliability and credibility of the Institute as keeper of the second radium standard. In the course of this project he hired two PhD students asking them to probe the exactness of the Viennese radium standards. In the end the exactness was proved and the credibility of the Radium Institute was re-established (Meyer 1945; Kremenak 1948). The success of Meyer's, as well as Karlik's, endeavours can be recognized in the appoint-

9 Interview with Karl Lintner conducted by the author on 9 June 2007 in Vienna.

10 Interview with Ferdinand Cap conducted by the author on 3 August 2007 in Innsbruck.

11 Letter from Hans Suess to Berta Karlik, 20 April 1947, and letter from C.H.F. Müller Aktiengesellschaft to Berta Karlik, 8 June 1949, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 32, fiche 448.

12 Letter from Berta Karlik to the Austro-Merck G.m.b.H., 7 October 1966, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 50, fiche 722.

13 Archive of the Austrian Academy of Sciences, Collection of the Institue for Radium Research, box 31, fiche 427–428. See also the correspondence between Stefan Meyer and Gustav Ortner, box 17, fiche 271.

ment of the Radium Institute as Austrian distribution centre for radioactive isotopes, which controlled the import and distribution of radioactive material in Austria from Harwell (UK) since 1949 and from the US since 1952 (Karlik 1950).

Nevertheless, cold winters, lack of resources and funds created delays in this regular business at the Institute until the end of the 1940s. This situation led to reduce the chances of establishing a new nuclear energy programme in any foreseeable future. This issue was also illustrated by a speech on international research in nuclear physics given by the experimental physicist Fritz Regler from the Technical University of Vienna before the Industrialists' Federation in 1949. Regler emphasized in the new possibilities of nuclear physics and its application, e.g. in the non-destructive examination of materials. However, implementing a nuclear energy programme seemed to him unrealistic because of the amount of necessary investments (Lackner 2000; Regler 1949).

Atoms for Peace in Austria

The peaceful use of atomic energy was one of the central ideas in the 1950s characterized by a public discourse and opinion dominated by a positive view over technology and progress at that time (Lackner 2000). However, it required an external incentive to translate these ideas into real opportunities for a small country like Austria. This ignition spark was given by the US President Eisenhower's famous Atoms for Peace speech before the UN General Assembly in December 1953 (Krige 2008; Krige 2006; Krige 2010; Hewlett and Holl 1989).

Eisenhower's envisioned programme had to face the practical difficulties raised during discussions with engineers. Already before Eisenhower's speech, the Austrian Electrotechnical Society (Elektrotechnischer Verein Österreichs, EVÖ) had initiated a series of lectures on nuclear physics in 1953 and 1954. From those, it seemed that the establishment of a study group had already been planned at that time but practical aspects, like the transfer from the Society to another building, and probably the absence of a concrete perspective for such a group, delayed the constitution of the group. Nevertheless, in December 1954, a formal study group was finally founded with members of the Technical University, among them Heinrich Sequenz, the former president of the TU until 1945, and members of the University, like Georg Stetter, the former head of the Four Year Plan Institute for Neutron, the physicists from Vienna University Hans Thirring, Erich Schmid, Karl Lintner, and of course Berta Karlik, the head of the Radium Institute, who had been a co-organizer of the first meeting, and Ministerialrat Alexander Koci as the government representative.[14]

14 Report about the founding of a „Studiengruppe Atomenergie im EVÖ" on 16 December 1954 from 10 January 1955, Archive of the Austrian Academy of SciencesVienna, Collection of the Institute for Radium Research, box 51, fiche 750.

Only five days after the constitution of the study group at the EVÖ the first government meeting on international cooperation for the peaceful use of atomic energy took place with participants of several ministries, except military or defence, but with only one representative of academia, namely Berta Karlik from the Radium Institute. No representative of the Austrian industry was invited. In this meeting it was decided to establish an advisory expert commission for the peaceful use of atomic energy, which was assigned to evaluate the possibilities and costs of a research reactor made in cooperation with the USA. Electricity production from nuclear energy was also discussed. However, at that time it seemed to be only a future possibility to complement other forms of electricity production.[15] After a meeting of the Council of Ministers in January 1955 and several other inter-ministerial discussions, the Minister of Education sent out a circular letter to all Austrian Universities in February 1955, in which he asked expert reports on a research reactor and on the possibility for energy production from nuclear fission.[16]

Another month later the universities had named the delegates for the commission and it was founded with subcommittees for experimental and theoretical nuclear physics, the application for nuclear energy in physics, chemistry, medicine, biology and one for the technical aspects of a nuclear energy reactor. This time all the delegates came from the universities except the one for the technical application and therefore one may imagine strong debates and opinion between the different institutions over the progress and vision of the project. Berta Karlik was assigned to conceptualize all the necessary memoranda, which underlined her central role again.[17] At that time still no representative of industry or the utilities was present.

In her report concerning the expediency of a construction of a nuclear reactor in Austria, Karlik expounded the different types of nuclear reactors, their purposes, and the costs involved. Furthermore, she gave a short analysis of the situation in other European states like France, Norway, the Netherlands, Sweden, Switzerland, Italy, West Germany, and Belgium. However, Great Britain and the United States were explicitly excluded from this analysis because of the engagement of the military in their nuclear research programmes. Karlik pointed out that all these European states installed or aspired to only research reactors and the financial situation in Austria would only allow the construction of a research reactor. However, she considered the financial requirements too high for the Ministry of

15 Austrian State Archives, Vienna, Collections BMU Atom, no. 157.959-INT/54.

16 Circular of the Federal Ministry of Education to the presidents of the Austrian Universities and Higher Education Institutes of 11 February 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 829.

17 Correspondence between the Ministry for Education and the University of Vienna, February and March 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 829.

Education even in the case of a research reactor. Therefore, she recommended an alliance of all concerned ministries, academia and industry. Besides she pointed out to another problem concerning the lack of qualified personnel for operating a reactor. For this reason, she recommended again the construction of a research reactor, where specialists could be trained in light of a possible future assignment in a nuclear power plant.[18]

The lack of qualified personnel was one of the main problems for the implementation of the project. Therefore, the Ministry of Education initiated a search for Austrian nuclear physicists abroad. Among them one of the central figures of Austrian nuclear research was eager to come back. Gustav Ortner, the former director of the Radium Institute from 1939–1945, was suggested by Karlik as coordinator of the project.[19] Ortner had held since 1950 a position as professor for experimental physics in Cairo and was in regular correspondence with Karlik even to the point of exchanging of material samples, which Karlik had sent to Ortner in Cairo.[20] Concerned about the possibility of missing this opportunity Ortner wrote a very gentle letter to the Ministry abstaining from any salary claims and Karlik on the other hand refused a request of the Ministry to name a second candidate.[21] Ortner, who finally got selected for the position of project coordinator, was sent to the US for training courses on the technique of nuclear reactors and was belatedly nominated as Austrian expert for the Atomic Energy Conference in Geneva in August 1955.[22]

The Austrian Council of Ministers, the highest decision-making body of the second republic, accepted the suggestions of the expert committee based on Karlik's recommendations shortly after Austria regained its full sovereignty in March 1955 and made the decision to build a research reactor, most probably with American support. One has to remember that these developments happened during the Cold War and Austria, which was occupied by the Allies until then, regained its sovereignty only for political neutrality. As a matter of fact, Austria also received offers for building a nuclear reactor from the Soviet Union. However, although these offers were notified and forwarded to the scientists, they remained

18 Report on the advisability of constructing a reactor in Austria written by Berta Karlik in April 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 49, fiche 706.

19 Letter from Berta Karlik to the Federal Ministry of Education, 28 April 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 829.

20 Correspondence between Berta Karlik and Gustav Ortner, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 46, fiche 665.

21 Letter to the Federal Ministry of Education, 28 April 1955; letter from Berta Karlik to the Federal Ministry of Education, 4 May 1955, and letter from Gustav Ortner to Berta Karlik, 17 May 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 829.

22 Letter from Berta Karlik to the Federal Ministry of Education, 16 July 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 830.

without responses, probably as a result of the conditions for the aspired integration of Austria into the Western bloc.[23] Karlik recommended the American technology for the comprehensive offer of training, supply of fuel elements and disposal of nuclear waste.[24] However, already in December 1954, in an inter-ministerial meeting only the American option was discussed even before the scientific advisory group was formed and the scientists were interviewed.[25] This indicates that the scientists may have been asked to follow the political orientation of their government.

Berta Karlik was from the beginning the central figure in the whole organization of the project and, around her, the Radium Institute and the members of the university. The Technical University only seemed to play the role of supporting actor in the project. This development led to the foundation of a separate study group at the Technical University in December 1955 to articulate the interests of the university on the prospects of new research resources.[26] These interests were clearly formulated half a year later in a letter of this study group to the Ministry of Education, where the author Sequenz stated the importance of engineers for the new developments in nuclear energy and that a new institute equipped with a research reactor should not be assigned only to the Viennese University but that the Technical University should benefit at least from the same equipment.[27] This latent conflict created a phase of tensions in the 1960s over the question of the access to the new resources.

However, before this internal conflict broke up, Austrian scientists demonstrated unity to the rest of the world at the First International Conference on the Peaceful Uses of Atomic Energy in Geneva in 1955. In preparation for the Conference, the Ministry of Foreign Affairs asked for a memorandum "that shows the world, that Austria is using for many years atomic energy for peaceful purposes and is one of the leading nations in that area."[28] In comparison to the debates

23 Letters from Federal Ministry of Education to Berta Karlik, 21 June and 5 July 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 830.

24 Letter from Berta Karlik to H. Küpper, 10 November 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 830.

25 Letter from Federal Chancellery for Foreign Affairs to Federal Ministry of Education, 6 December 1954, Austrian State Archives, Vienna, Bestand BMU Atom, Zl. 157.605–INT/54.

26 Minutes of the meeting from 19 December 1955, Archive of the Vienna University of Technology, R.Z. 2787/55, p. 31.

27 Letter from Heinrich Sequenz to the Federal Ministry of Education, 6 July 1956, Archive of the Vienna University of Technology, R.Z. 2787/55, pp. 32–33.

28 „Der Welt soll gezeigt werden, dass Österreich seit Jahren Atomenergie für friedliche Zwecke verwendet und auf diesem Gebiet zu den führenden europäischen Nationen gehört." (English translation from the author), Federal Chancellery for Foreign Affairs to Institute for Radium Research, 27 January 1955, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 50, fiche 727.

about Austria's accession to CERN it seems like scientists were successful with their reasoning, as it was now taken over by the politicians. Berta Karlik was asked again to prepare a report. Most of the report discussed the use of radioactive isotopes in all kind of fields: from medical to scientific and industrial applications. The last section focused on the plans concerning a reactor, where she stated:

> Austria is considering the building of a research reactor as a joint project of science and industry and is engaged in preparations. It is expected that within a period of one year it will be possible to clear the major problems as there are the juridical form of cooperation of partners in the project, the financial problem, the coordination of the research programmes as well as the reactor type, a time schedule, etc. – The construction of a power reactor is not considered advisable at the moment.[29]

The conference was a catalyst on Austrian developments, but not in the way it was hoped for by the scientists. In parallel to the academic study groups an alliance between energy utilities, industry and politicians had been formed. This alliance led to the founding of the Österreichische Studiengesellschaft für Atomenergie GmbH (Austrian Society for Atomic-Energy Studies Ltd.) on May 15, 1956. The organization held a capital stock of 6 Mio öS with 51 % from the state and 49 % from the industry. Although the association existed of more than 80 companies, there was only one scientist (Gustav Ortner) in the Society's board of management present. However, scientists were invited to participate in the newly founded research groups, e.g. on biology, medicine, safety issues, research and power reactors, metallurgy, physics, chemistry, legal questions etc.[30] In June 1956 a contract concerning the cooperation for the civilian uses of atomic energy was signed between the United States and Austria and it was decided to construct a rector centre with an ASTRA swimming-pool reactor in Seibersdorf near Vienna. 40 % of the required 102 Mio öS investment were covered by the fund of the European Recovery Program and 9 Mio öS were directly subsidized by the American Atomic Energy Commission (Müller 1977, 83–87; Lackner 2000, 209–212).

In the course of planning, the scientists' views were heard but they had the weakest position in the struggle for financial and personnel resources and in the question of who would define the areas of future research. Finally the close cooperation between academia and industry failed in May 1957 when the decision

29 Draft of a memorandum, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 55/56, fiche 825.

30 Federal Ministry of Education to Berta Karlik, 23 August 1956, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 832.

Figure 1 The research centre Seibersdorf during its construction in 1959

was made that the new reactor centre should no longer be coordinated by a university's institute.[31] On their side, however, the universities enforced their claims for the construction of their own research reactor project, which was finally approved at the end of August 1957[32] and led to the foundation of the Atomic Institute of the Austrian Universities in 1959, which received a TRIGA Mark II reactor supplied by General Dynamics for USD 258.625,00 called "Austria 30".[33] The location of the Atomic Institute and the research reactor of the Austrian universities was heavily debated in the public spheres, because the scientists' first choice was a flak tower, an above-ground bunker built during the NS era in the Augarten, a central pleasure ground in Vienna. The proposal sparked massive public protest, and it was relocated to the Prater, which is a green area on the periphery of the city.[34] The new institute was formally attached to the Technical University for administration but the rules of procedure determined that the new Atomic Institute should be opened for research to members of all Austrian universities.[35] Nevertheless, the two directors, Gustav Ortner and Fritz Regler who were nominated in March 1961 when the construction was still in progress, came from the Technical University.[36] The discussions about the rules of procedures, especially about the access to the new research and teaching resources, led to strong debates between the Technical University and the other universities up to the point where the University of Vienna asked its Faculty of Law for legal support. This fight resulted, however, in having the Atomic Institute incorporated into the Technical University at the

31 Federal Ministry of Education to the presidents of all scientific universities, 24 May 1957, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 832.

32 Federal Ministry of Education to the presidents of all scientific universities and the Deanery of the Faculty of Catholic Theology in Salzburg, 30 August 1957, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 833.

33 Contract between the Federal Ministry of Education and the General Dynamics Cooperation, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 834/835.

34 Memorandum on the meeting of the Action Committee for Atomic Energy, Tuesday 1 April 1958 in the small conference room of the Federal Ministry of Education, written by Fritz Regler, 2 April 1958, Archive of the Vienna University of Technology, R.Z. 1250/58, p. 70.

35 Draft of an enactment of the Federal Ministry of Education regarding the assignment of the Atomic Institute, 2 February 1959, Decree of the Ministry from 20 February 1959, Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 834.

36 Minutes of the 5th meeting of the Atomic Commission of Austrian Universities on 11 March 1961 at 10 am in the large conference room of the Vienna University of Technology. Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 836.

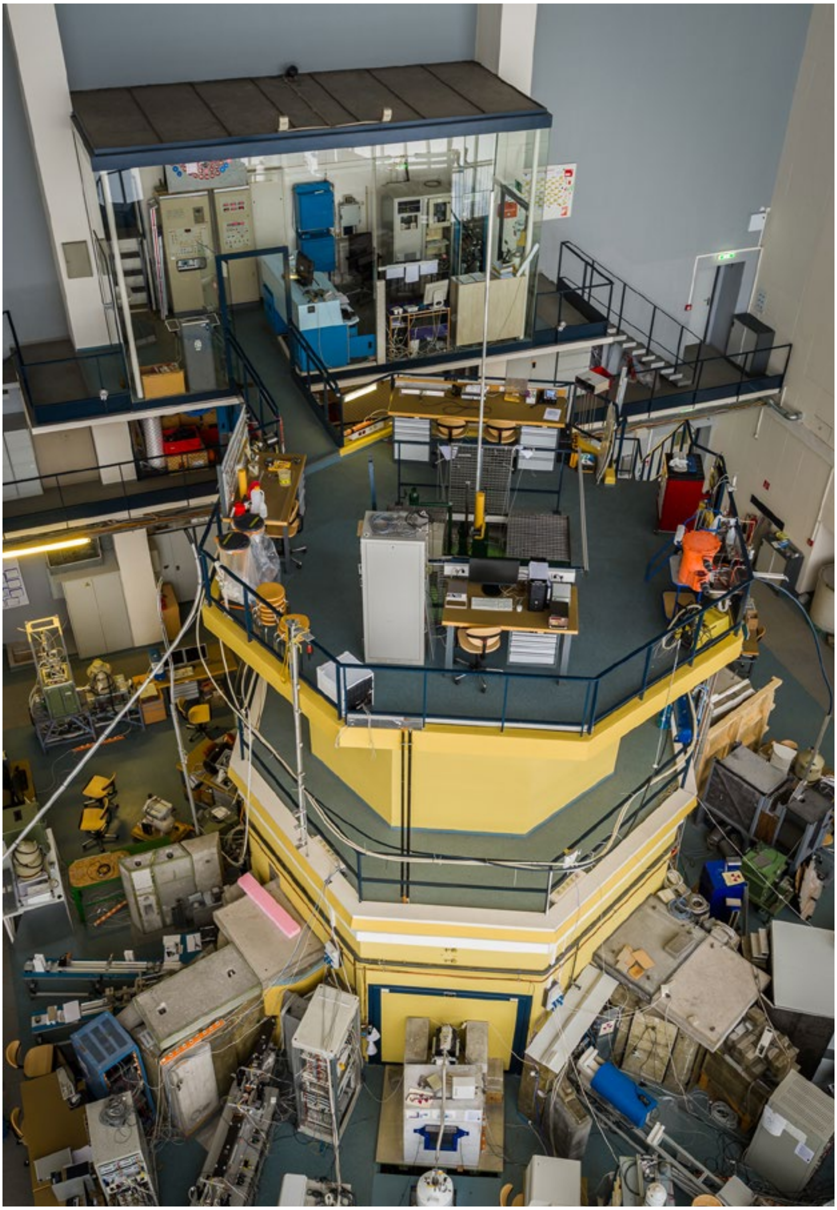


Figure 2 The TRIGA Mark II reactor of the TU Vienna

beginning of the 21st century.[37] Finally, three research reactors went into operation: The ASTRA reactor of the industry dominated Studiengesellschaft at Seibersdorf in 1960, the TRIGA Mark II of the Austrian universities at the Prater in Vienna in 1962, and a small sub-critical reactor of the technical universities in Graz in 1963. The latter was financed by the Federal State Styria and the local industry and was developed independently from the main negotiations in Vienna.

The nuclear power plant in Zwentendorf

Energy production in Austria was until the late 1980s a government monopoly. Besides the central Verbund Corporation (Österreichische Elektrizitätswirtschafts-AG, Austrian Industry Electricity Stock Corporation) which was controlled by the Federal Government there was one electricity provider in every state that was controlled by the particular Federal State Government. When the research reactors were constructed and started up at the beginning of the 1960s electrical energy production from nuclear fission was still a dream of the future as the necessary investments seemed too high for a profitable energy production in comparison to hydropower and fossil-fuelled thermal power plants. Even a predicted doubling of the energy consumption in Austria in the decade from the mid-fifties to the mid-sixties was not enough to make nuclear energy a profitable endeavour. Nevertheless, as early as 1960 the Verbund Corporation asked for a report about possible locations for a nuclear power plant (Schaller 1997, 112–14). However, even though the predictions concerning the consumption of electricity were relatively accurate, the main problem remained that hydropower could not cover the increasing consumption and therefore there was no other choice than increasing the share of electricity production from fossil fuels (Lackner 2000, 216–217).

By the end of the 1960s the electricity companies started together with the conservative government an initiative for nuclear energy production in Austria. In October 1967 the Ministry of Transport and State-Owned Companies (Bundesministerium für Verkehr und verstaatlichte Betriebe) arranged a hearing concerning atomic energy in Austria with explicit reference to electricity production from nuclear fission. The positions in the electricity companies were heterogeneous at that time, especially about when a nuclear plant might be necessary; in particular contrast to the conservative government that forced a quick start on the beginning of construction (Forstner 2016b).

One of the results of the experts' hearing was the foundation of the Kernkraftwerksplanungsges. m.b.H (Nuclear Power Plant Planning Corporation Ltd.) in April 1968 and later, after the location was chosen, a construction company named

37 Archive of the Austrian Academy of Sciences, Vienna, Collection of the Institute for Radium Research, box 56, fiche 836/837/838, in here especially: Report of the Dean of the Faculty of Law and Social Sciences of the University of Vienna dated 27 March 1962, fiche 838.

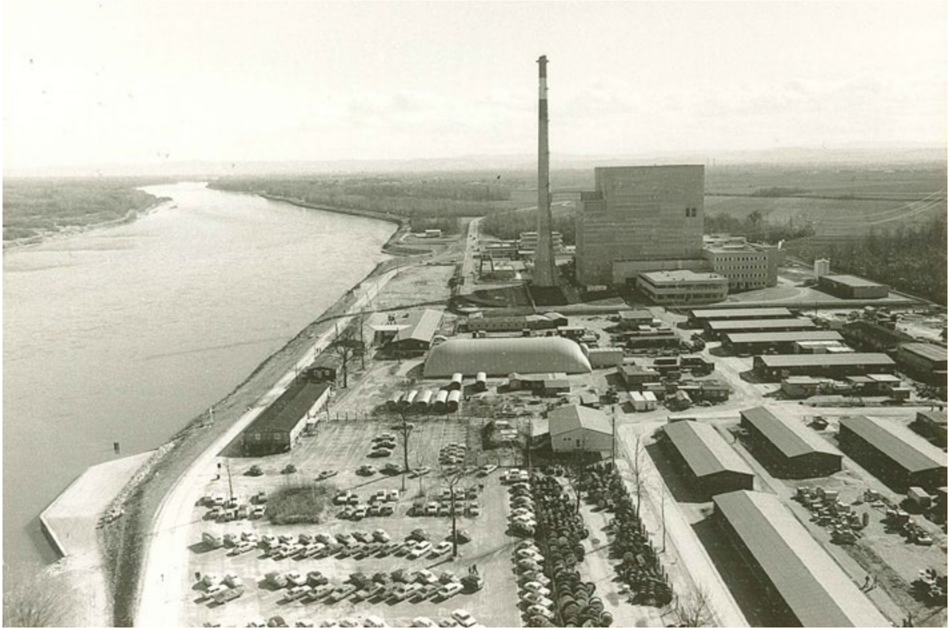


Figure 3 The NPP Zwentendorf during its construction

after the area Tullnerfeld the Gemeinschaftskraftwerk Tullnerfeld Ges. m.b.H. (Corporation Power Plant Tullnerfeld Ltd) was founded. Problems in the demarcation of the responsibilities of the two companies led to the decision that the latter was in authority for the concrete planning of the plant in Zwentendorf while the former was to plan all future Austrian nuclear power plants. The central Verbund held 50 % of each corporation; the other 50 % were divided among the seven federal state companies. Quarrels between these companies considerably delayed the start of construction. Three years later the Austrian government under Chancellor Kreisky made the planning and building decision in March 1971 and a consortium of the Austrian Siemens Ges. m.b.H, the Austrian Elin Union AG, and the German Kraftwerk Union AG was chosen to build the plant. Their offer for a turnkey boiling water reactor of the consortium was not considered the best (the government thought that the Swedish ASEA made the best offer) but it was regarded as a chance for the Austrian industry to prove their abilities in the construction of nuclear power plants and, more broadly, it may also be seen as a part of the Keynesian economic policy in place at that time in the Kreisky era (Forstner 2016b; Lackner 2000, 219–220).

After several hearings the building permission was granted and construction started in March 1972 and in 1976 two further nuclear power plants were planned for 1990. Just after the Swedish Social Democrats lost their majority at the national parliament elections in 1976 probably because of their atomic policy, a public discussion process was initiated and supporters as well as opponents were heard. The start-up of the plant in Zwentendorf was delayed several times and finally Kreisky initiated a referendum about the launch, promising to resign should the referendum fail. The referendum resulted in 50.47 % of votes against the start-up coming from opponents to nuclear power as well as probably also conservatives supporting the technology but hoping to get rid of Kreisky, hence voting against Zwentendorf NPP for political reasons. However, this strategy failed altogether. Kreisky quickly reacted and about one month after the referendum the Parliament passed without any dissentient vote the *Atomsperrgesetz*, a law that forbade the use of nuclear fission in Austria for energy production. A two-thirds majority rule in parliament and another referendum protected the law from being easily revoked. Nevertheless, nuclear research was excluded from this ban. Following the Three Mile Island accident in the USA in 1979, as well as several failed attempts to withdraw the *Atomsperrgesetz*, the Austrian plans to establish nuclear energy were finally cancelled. In 1986, the Chernobyl accident in Ukraine helped the anti-nuclear movement to receive more and more public attention and acceptation, although the accident had no direct effect on the Austrian decision (Forstner 2016b).

This development led to a new law, now part of the Austrian Constitution:[38] The Bundesverfassungsgesetz für ein atomfreies Österreich (Constitutional law for an Austria free of nuclear tasks) determined that in Austria:

- Nuclear weapons cannot be produced, tested, stored or transported,
- nuclear power plants cannot be constructed anymore and those that are already built cannot start operation,
- transport and storage of compounds for nuclear fission are forbidden, except those for peaceful uses although not those for energy production,
- the Republic of Austria is liable for any injuries due to accidents with radioactive compounds or has to enforce the claims from foreign causers,
- the Federal Government is responsible for the implementation of the law.

Today it seems evident that there is no intention for further developing nuclear power in Austria in any foreseeable future. After a legislative initiative of the Social Democrats had failed in 1985 it was decided to use the Zwentendorf power plant

38 Federal Law Gazette for the Republic of Austria, issued on 13 August 1999, no. 149. Federal Constitutional Act for a nuclear-free Austria, viewed on 26 March 2009 on http://www.salzburg.gv.at/1999a149.pdf.

in the best way possible. In the further course the power plant was transformed into a stock of spare parts for West German plants of the same type and used as a training area for nuclear engineers. Today's criticism focuses on the high cost (14 billion öS) for such a training plant paid for by the Austrian taxpayers. Anecdotally, the power plant was also used for a film setting with the Swedish actor Dolph Lundgren, although the production company ran out of money and the film was never finished.[39] This makes an interesting parallel with the actual fate of the nuclear power plant.

Presentation of main actors

Academia had a long tradition in radioactivity and nuclear research. The Institute for Radium Research was founded in 1910 and was the first Institute of this kind. It was financed by the Austrian Academy of Science and the University of Vienna. Until the Institute was split up in the 1970s there was a close cooperation between the Institute and Vienna University.

In the early discussion until 1956 academia was the driving force for the construction of a nuclear reactor in Austria. All committees were manned by scientists from academia, especially the Radium Institute, the University of Vienna, and the Technical University of Vienna. Other Austrian universities were engaged in the discussion, but played only a minor role. The central figure of the whole discussion was Berta Karlik. She served as director of the Radium Institute, and was the first woman at Vienna University who got a full professorship. She drafted all the memoranda and reports for the conference in Geneva, as well as a feasibility study on a nuclear reactor in Austria in 1955. Academia lost their central position in 1955 when industry and the Austrian utilities entered the discussion treating directly with the government. In the course of the construction of Austria's first nuclear power plant academia took only a minor role.

Industry and utilities: Before 1955, early interest in the nuclear technology concerned very few companies, including Waagner-Biro (steel, machine building industry), the Österreichische Stickstoffwerke AG (chemistry), ELIN AG/ELIN-UNION AG (electrical engineering), and the Simmering-Graz-Pauker AG (machine building, motor, and electrical engineering). A meeting at the Central Austrian Utilities (Verbundgesellschaft) led to a union of the industrial interests, and to the founding of the Österreichische Studiengesellschaft für Atomenergie m. bes.H. In this corporation Austrian utilities took a leading role, as well as the above-mentioned companies. However, Austrian government kept a slight majority

39 Newspaper *Die Presse,* 13 October 2008.

(50.48 %) of the corporation's share. It is the industry that convinced the government to develop nuclear energy production at the end of the 1960s.

The **Austrian government** welcomed the US offer to build a research reactor in the context of the Atoms for Peace programme. Soviet offers circulated among the main actors, but no further discussion followed. The conservative government in the 1960s was in favour of nuclear energy as well as the Social Democratic Party in the 1970s. However, in the 1960s the conservative government was forced by the industry to complete the development plans in order to effectively start designing and building NPPs. When the anti-nuclear movement became stronger in the mid-1970s the conservative party started questioning the security of the Zwentendorf NPP. At that time the Social Democratic Party also changed their public policy and initiated a public information campaign. In 1978 it was impossible to find a consensus between the conservative party and the Social Democratic Party concerning the start-up of the Zwentendorf NPP. This led Chancellor Bruno Kreisky to initiate a referendum resulting in a slight majority against the start-up. Several attempts were made to revoke the result of the referendum. Finally, after a last attempt by the Social Democrat and Chancellor Fred Sinowatz failed in 1985, all further plans for implementing nuclear power in Austria were definitely abandoned.

The public: In the 1950s the Austrian government tried successfully to establish a positive view of nuclear energy in the public supported by the United States and their manifold information services. This positive view held up until the construction of the Zwentendorf NPP. At the beginning of the construction there were only local protests and opposition by conservative and right-wing groups of the early ecology movement which was strongly influenced by German eugenics *(Rassenhygiene)*. In contrast to the past the government did not waste time in any public relation work until the mid-1970s and the positive view of nuclear energy got lost in the public. Especially, when Maoist groups of students entered the field in 1975, and the anti-nuclear movement began to broaden. Finally, it extended across all social classes and social groups which became divided around this question.

Showcase: The Austrian Anti-Nuclear Movement

While the anti-nuclear movement in Germany has already been well studied, the Austrian movement has not attracted the same attention.

In the early years, there was only sporadic and local criticism of nuclear power, which was ignored on the whole. For this form of criticism, a memorandum of the Lower Austrian Chamber of Physicians from 1969 serves as illustration. This is the first sign of protest against the construction of the nuclear power station at Zwentendorf. After Zwentendorf had been set as the site for the nuclear power station, Rudolf Drobil, representing the Lower Austrian Medical Association, together with the biologist Gertrud Pleskot, from the University of Vienna, attended Andreas Maurer's surgery and tried to dissuade the lower-Austrian state governor from constructing the nuclear power station because of potential health hazards. As they failed in their face-to-face negotiation, they made the memorandum public (Straubinger 2009, 211–212).

In this memorandum, they demanded not only the participation of nuclear physicists and nuclear engineers in the design of the power plant but also the involvement of those qualified to judge the health and environmental impacts of radiation such as doctors and biologists. The authors of the memorandum stressed that any kind of high-energy radiation is detrimental to the human body and its cells regardless of the size of the dose. In particular, they pointed out the risk of damage to the genome through ionizing radiation. As examples of the victims of such radiation, they listed the first scientists who worked with X-rays or radioactive materials; they also cited the victims of radioactive radiation due the atomic bombs dropped on Nagasaki and Hiroshima. The authors of the memorandum cautioned that even after the most accurate surveys about the potential dangers, and the little consideration they had been given, potential risks will always exist. For instance, even if the probability of an earthquake occurring was *thought* to be extremely low, it could not be ruled out entirely. Moreover, the authors argued that radioactivity discharged into the environment would accumulate over time in organisms. As evidence, they quoted figures from measurements at the Hanford site in the USA. In addition, the authors questioned the viability of a nuclear power station and highlighted the opportunities for expanding hydropower in Austria. After considering all of these factors, the authors concluded that it was not worth taking the risk of building a nuclear power station.[40]

This memorandum attracted as little attention as the first early protests of the Bund für Volksgesundheit (Union for Public Health), in which Richard and Walther Soyka were the main protagonists. After the death of Richard Soyka, his son

40 Soyka, Hermann, The „Bund für Volksgesundheit", 2007, http://www.academia.edu/6641682/Der_Bund_fuer_Volksgesundheit, accessed 14 March 2007.

Walther took over the management of the Bund für Volksgesundheit, which derived from the eugenic/racial-hygiene movement. It was founded in 1926, dissolved after the occupation and annexation of Austria by Nazi Germany and was founded again in 1946. The main topics preoccupying the Bund in the post-war period were diet, alcohol and nicotine abuse. With plans for an Atomic Institute in Austrian higher education, health effects from radioactivity became one of the Bund's concerns. In the early phase of protest against Zwentendorf, the Bund demanded a referendum against contamination from nuclear reactors (1969) and organised two marches in 1970 as protest actions, in which protestors starting from different places converged on Zwentendorf. Headed by Walther Soyka, a Society for Biological Safety (Gesellschaft für biologische Sicherheit) was also founded in 1970, whose goal was to oppose to nuclear energy.[41] In March 1972, Walther Soyka, equipped with hundreds of powers of attorney from residents who lived close to the site of the planned nuclear power station, attempted to participate in the hearing for the licensing procedure at the parish hall in Zwentendorf. Since local residents did not have a stakeholder status according to the Radiation Protection Act, Soyka was finally ousted by the police from the parish hall after the protest. In 1972, Soyka became a co-worker at the University of Bremen and moved in circles on the edge of the right-wing spectrum (Geden 1996, 116) until his candidacy as an independent for the Nazi party Deutsche Volksunion in the German federal elections for the Bundestag (German parliament) in 1998 (Hertel 1998, 26).

The Bund für Volksgesundheit collaborated intensively with the Weltbund zum Schutz des Lebens (World Union for Protection of Life), which was also conservative tending to "ethonationalistic". German and Austrian sections of the latter were established in 1960 by Günther Schwab, and the environmental historian John Straubinger concludes in his analysis of Schwab's work that he indeed had a considerable propinquity to National-Socialist ideology but was the first to warn about the dangers of nuclear power in Germany and Austria in his work (Geden 1996, 105–107; Straubinger 2009, 65–75). His book *Morgen holt dich der Teufel. Neues, Verschwiegenes und Verbotenes von der „friedlichen" Atomkernspaltung,* which appeared in 1968 in Germany and Austria, played an important role in this respect (Schwab 1968). In his book, Schwab took the form of a dialogue to provide facts and arguments for the opponents of nuclear power. Thus, for example, Peter Weish, a former employee at the research centre Seibersdorf and later head of the anti-nuclear movement in Vienna, recalled in an interview the important role the book played in his own opposition to nuclear energy.[42] However, the initial protests did not manage to achieve a widespread attraction within the population.

41 Interview with Peter Weish, conducted by the author on 16 February 2016.

42 See, for example, *Arbeiterzeitung*, 21 September 1976.

In the Federal State Upper Austria and in its capital Linz, resistance against a planned second nuclear power station in Stein/St. Pantaleon stirred early. This protest led finally to the broadening of the anti-nuclear movement across the whole country. The resistance there was instigated by the Naturschutzbund (Environmental Protection Group) and the Weltbund zum Schutz des Lebens, later joined by the Maoist-oriented Kommunistische Bund Linz (Communist Confederation Linz). The latter was the driving force in the working group Nuclear Energy Linz and was popular especially among students. The Upper Austrian anti-nuclear movement spanned the entire political spectrum from the left to the right. Due to its heterogeneity disagreements often occurred concerning the most affective forms of action to achieve the shared goals. A decisive step towards the unification of the movement was taken in the side-lines of a lecture given by Karl Richard Bechert, a nuclear power station opponent and nuclear physicist from Germany. Functionaries of the Austrian Naturschutzbund, Upper Austrian activists and the Viennese group surrounding Peter Weish and Bernhard Lötzsch formed a network. Furthermore, the Upper Austrian nuclear power station opponents united in the Bürgerinitiative gegen Atomgefahren (Civil Initiative against Nuclear Hazards) (Straubinger 2009, 211–212).

The Austrian anti-nuclear campaign gained additional impetus from events in Germany. As the construction of the Württemberg nuclear power plant in Wyhl began in February 1975, demonstrators successfully occupied the building site for nine months. A panel discussion in Linz in April 1975, with more than 3,500 participants, represented the first high point in the development of the Austrian anti-nuclear campaign. Both the Minister of Trade Staribacher and Chancellor Kreisky took part in the event. Discussion was turbulent, and it was broadcast on TV to all of the federal states of Austria. Nuclear energy was no longer a local issue; it was now a concern of the entire federal territory. In almost all cities and universities, working groups and action groups were formed that made it their business to inform people about the dangers of nuclear energy (Bayer 2014, 173).

Federal Government came under increasing pressure by this development, and in October 1975 federal elections for the parliament were imminent. On 1 April 1975, Staribacher announced a provisional construction freeze on the proposed nuclear plant (AKW) at Stein/St. Pantaleon for economic reasons. In April 1976, the Federal Government initiated an information campaign in ten Austrian cities, in which experts discussed various aspects of nuclear energy and faced questions from the general public. Both supporters and opponents of nuclear energy were represented among the experts. Through this campaign, a strong course of confrontation like in the Federal Republic of Germany was to be avoided.

However, the nationwide unification of the different anti-nuclear groups was one of the consequences of the chancellor's nationwide initiative. In May 1976, the representatives of the various groups met and formed an umbrella organization the Initiative Österreichischer Atomkraftwerksgegner (Initiative of Austrian Nuclear Power Opponents). Their goal was to prevent the Zwentendorf nuclear power station from being commissioned (Straubinger 2009, 211–212).

The result of the September 1976 elections in Sweden probably also influenced the turnaround in the politics of the Austrian Federal Government. The Swedish Social Democrats under the leadership of Olof Palme lost the election partly because of its nuclear policy. (See Sweden's chapter.) The events in Sweden were reported in detail in the *Arbeiterzeitung*, the daily newspaper of the SPÖ.[43] Kreisky declared, two days after the elections in Sweden, that the construction of nuclear power station Stein/St. Pantaleon be frozen until the question of disposal of nuclear waste had been cleared.[44]

The information campaign of the Federal Government was launched in October 1976 and ended ultimately in a fiasco for the government. The events in autumn of 1976 and spring of 1977 were clearly dominated by the anti-nuclear activists. Thus, the IAEA recorded in its files:

> 9 December 1976, Salzburg: "Judging the Risks at Nuclear Power Stations." This turned into a festival for professional demonstrators, using speaking choruses. The main scientific opponents, Dr. Bernhard Lötsch and Dr. Peter Weihs [sic] from Vienna's Boltzmann Institut für Umweltwissenschaften received ovations. [...]
> 27 January 1977, Vienna: "Effects on Society and Control of Operation of Nuclear Plants." This was the biggest demonstration of anti-nuclear groups in Austria, about 1000 persons attended, 90% of them anti-nuclear. No discussion was possible, only opposition groups made their demands known and elected their chairman. After this, official organizers asked themselves if the campaign should be continued in this climate.[45]

Some of the events proceeded more quietly; however, overall, it can clearly be said that the Federal Government's campaign was a failure. During 1977, there were several nationwide actions and demonstrations, and the situation for the government worsened progressively (Bayer 2014, 173).

43 *Arbeiterzeitung*, 22 September 1976.
44 Nuclear controversy in Austria, 1976–77, IAEA Archives, Vienna, box 15521.
45 Bundesministerium für Inneres, Nationalratswahlen, historical review, http://www.bmi.gv.at/cms/BMI_wahlen/nationalrat/NRW_History.aspx, accessed 25 May 2016.

Figure 4 Anti-Nuclear Demonstration in Vienna in 1977

As it had become obvious in the spring of 1978 that a common parliamentary resolution between ÖVP and SPÖ for commissioning the Zwentendorf nuclear power station was not going to be achieved, the SPÖ leadership decided to seek a decision in a referendum. During the preparation for this referendum, the working group NEIN zu Zwentendorf (NO to Zwentendorf), with the geologist Alexander Tollmann at its head, was founded from the conservative parts of the anti-nuclear movement. Eventually, they just managed to assert themselves in the referendum thanks in part to the lack of mobilization in the supporters of the SPÖ (Forstner 2016b).

Events

Critical view to the selection process of the three events

Reasons for choosing the events:
- The Austrian plebiscite in November 1978 marks the failure of the Austrian nuclear energy programme. The date is crucial for Austria and cannot be neglected. The analysis shows that the Socialist Party failed to mobilize its supporters for the referendum.
- A ship's christening shows how local traditions of protest and civil resistance later developed as anti-nuclear protests. These protests started against the Swiss NPP in Rüthi next to the Austrian border, and later focused on the Austrian NPP.
- The IAEA and the Austrian events show how local/national events influenced the policy of a transnational organization. In this case the Austrian referendum led to a public acceptance programme of the IAEA.

Event 1: The Austrian plebiscite in November 1978

In 1977 nuclear power and the start-up of the NPP Zwentendorf had become a political issue due to the increasing public protests during the years 1976/77. The government passed the decision on nuclear power on to parliament. The Socialists were sure they would come to a mutual agreement with the major opposition party the People's Party because the latter's most influential groups were clearly in favour of nuclear power. A report on nuclear energy was submitted to parliament by the government.

Federal State	Yes in %	No in %
Burgenland	59.8	40.2
Carinthia	54.1	45.9
Lower Austria	50.9	49.1
Upper Austria	47.2	52.8
Salzburg	43.3	56.7
Styria	52.8	47.2
Tyrol	34.2	65.8
Vorarlberg	15.6	84.4
Vienna	55.4	44.4
Whole	**49.5**	**50.5**

In the course of the parliament hearings the People's Party reconsidered its position and declared itself pro nuclear power but against the start-up of Zwentendorf for security reasons. Therefore, Chancellor Kreisky decided not to ask the parliament for the final decision and instead announced a referendum in June about the start-up.

The plebiscite took place on 5 November 1978. Only 64.1 % of the eligible voters took part in the plebiscite, of which 50.47 % were against the introduction. The results in each one of the federal states show that those in the Western federal states were least in favour of the plant being switched on.

The SPÖ had not succeeded in mobilizing its followers. This argument is supported by the low participation of voters. Whilst turnout in the referendum was 64.1 %, turnout in the 1971, 1975 and 1979 national parliament elections was solidly between 91 % and 92 %.[46] The anti-nuclear tradition in the most Western state Vorarlberg will be discussed in event number 2 "A ship's christening."

Kreisky reacted quickly and a month after the referendum the parliament passed without any dissenting vote the *Atomsperrgesetz*, a law that forbade the use of nuclear fission in Austria for energy production which could only be altered by a two-thirds majority in parliament and another referendum. Nevertheless, research was excluded from this ban.[47]

The enriched uranium and the fuel elements were sold to the US. Much of the planning cooperation was liquidated from 1979 onwards. Finally, the planning

46 Federal Law Gazette for the Republic of Austria, year 1978, issued on 29 December 1978, 232 copies.

47 Austrian Journal *Alle Parteien gegen Atomkraft*, no. 94, 1 April 2011, pp. 1–11.

cooperation for Zwentendorf, which was the Gemeinschaftskraftwerk Tullnerfeld GmbH, was liquidated in 1985 after the Socialist Chancellor Fred Sinowatz failed to revoke the *Atomsperrgesetz* in parliament. Austria's final No to nuclear energy was therefore clearly before the Chernobyl accident. [48]

Event 2: A ship's christening, November 1964 (basis for anti-nuclear protests in Western Austria against the Swiss NPP Rüthi)

In the table above is shown that Austria's most Western state Vorarlberg voted at 84.4% against the start-up of the Zwentendorf NPP. This is by far the highest rejection rate of all Austrian federal states. In comparison to other Austrian states Vorarlberg had the longest tradition of civil protests, including against nuclear power in Switzerland.

Since 1971, massive protests by the Naturschutzbund (Environmental Protection Group) with the support of the Weltbund zum Schutz des Lebens began here against Rüthi, the Swiss nuclear power station close to the border. However, the inhabitants of Vorarlberg could look back on a tradition of protest before the demonstrations against the Swiss nuclear power station. The so-called Fußach Ship Christening in 1964 was written in the consciousness of the population of Vorarlberg as an act of civil resistance. On 21 November 1964, an angry group of approximately 20,000 local inhabitants prevented the christening of a ship of the Lake Constance fleet with the name "Karl Renner", the first SPÖ Federal President in Austria since 1945. The Lake Constance fleet was subordinate to the Austrian federal railway, which was in turn assigned to the Department of Transportation under Minister Otto Probst. As the Ministry of Transport made the planned name known, anger stirred in the Vorarlberg population against "Viennese centralism". The anger was additionally fueled by the *Vorarlberger Nachrichten*, the local leading media. After the abolition of the monarchy, christening ships after personalities was waived for less controversial names. The state government of Vorarlberg decided not to send any representative to the ship's christening in protest; instead, the 20,000-strong group of Vorarlberg inhabitants gathered in the harbour of the community Fußach and conducted an emergency christening of the ship in which they gave it the name "Vorarlberg". In the collective consciousness of Vorarlberg, the Fußach Ship Christening is still considered today as an example of successful protest against Viennese centralism.[49]

Between 1972 and 1975, up to 20,000 Vorarlberg inhabitants marched in the so-called Anti-Rüthi Marches across the border to Switzerland. These actions were

48 Interview with Hildegard Breiner, conducted by the author on 29 June 2012 in Bregenz.

49 Ibid.

Figure 5 Demonstration in 1964 against the ship's christening with the name "Karl Renner" in Western Austria

supported in turn by the Vorarlberger Nachrichten, which also played a major role in the later resistance against the Zwentendorf nuclear power station. Protest went so far in Vorarlberg that even the state representatives of the Vorarlberg SPÖ called for a "NO" to Zwentendorf contrary to the guidelines of the federal party. The high "NO" vote, 84 %, of voters in Vorarlberg in the referendum on Zwentendorf cannot be understood as a simple "NO" to the Chancellor Kreisky; its roots have to be seen instead in a long-standing tradition of civil resistance and protest against nuclear power in Austria's Western-most federal state.[50]

Event 3: The IAEA and the Austrian events

The International Atomic Energy Agency in Vienna began to pay a close attention to the Austrian debates from 1977. It did not limit its interest to the activities of the opponents to nuclear power, but also recorded the activities of advocates in their files. These files include a detailed description of the various groups, their main representatives and the central arguments on which they based their views. After the announcement of the referendum, the depth of detail in the observations increased again. In addition, observations were extended, probably from March 1978, to all democratic countries of the Western world, and all activities associated with "nuclear controversy" were recorded in the files.

The IAEA did not actively intervene in the Austrian nuclear debate. The Swedish IAEA Director General Sigvard Eklund thus made almost no public statement on Zwentendorf. Public statements such as those in a television interview for the Austrian news programme Zeit im Bild on 21 September 1978 remained the exception. However, the Agency did make information available to those who advocated for nuclear power plans. It supplied the Austrian utilities with information three months before the referendum and also gave daily newspapers and the ORF information about the disposal of radioactive waste.[51]

In addition, the IAEA initiated a traveling exhibition on its 20th anniversary, which showed a map of nuclear power stations in the countries bordering Austria and discussed disposal and safety issues. After the exhibition in the Kärntnerstraße was destroyed in its first night, 24 October 1977, it was moved for the months of November and December 1977 to Vienna's city hall. In May 1978, it was On 23 November 1978, the IAEA hosted an information event for the Austrian referendum. Altogether 21 people participated: four from Switzerland, two from the Federal Republic of Germany, three from Sweden and one representative each

50 Information output in connection with Austrian referendum as known to OPI [Office for Public Information], IAEA Archives, box 15521

51 Information Meeting on Austrian Referendum held on 23 November 1978, Files from D.G.'s [Director General's] Office – 1978, IAEA Archives, P-156 box 4.

from France, the Netherlands, Spain and Italy. First, a representative of the Austrian Federal Chancellery spoke on the background of the referendum and to the measures pending to cast the results of the referendum into legislation.[52]

Subsequently, a first error-analysis combined with behavioural advice for similar situations was given. These included the following points: It was recommended that in principle no more than 50 people be in the audience for an information session. For discussions sufficient time should be allowed; the presentations should therefore be kept short. It seemed of even greater importance to allow sufficient time for informal discussions. The audience should be taken seriously; questions should be answered with a detailed response and not be avoided. The risks of nuclear energy should be mentioned from the beginning in order to avoid having to admit in the course of the discussion that there are "minor problems" yet to be solved. Grossly simplified presentations should not be given neither should simplistic comparisons between the risks of nuclear energy and the dangers involved, for example, in an hour's skiing or drinking half a bottle of wine. Exclusively people with a broad foundation of knowledge on the subject of energy should be sent to such discussions. In this way, it was hoped that speakers would not be so specialised that they could not answer general questions, which shook an audience's confidence in the expert's knowledge. In addition, efforts should be made in personal discussions to find common topics of interest not remotely connected to nuclear energy in order to show that nuclear scientists are also ordinary people with ordinary interests.[53]

The participants to the meetings were grateful for the information as well as the opportunity to exchange experiences over lunch. The importance of the forthcoming Swiss referendum on 18 February 1979 over nuclear power was emphasized. For the French-speaking part of Switzerland, the public relations officer of the French Commissariat à l'Energie Atomique (Atomic Energy Commissariat) offered support, which was well received by the Swiss participants. Likewise, the IAEA's offer of a brochure on radioactive waste disposal was welcomed since this topic touched the core of the Swiss debate. Basically, there was a desire to examine the implications of the Austrian referendum for other countries as well as the question whether the results of the referendum could be used by opponents to nuclear energy for their own purposes. Furthermore, a request was made to the IAEA to either promote the benefits of nuclear energy more actively or set out its advantages compared to alternative sources of energy.[54]

In the short term, the IAEA would not only be present at pro-nuclear events but also in those which deal with energy issues in general. Members of parliament

52 Ibid.
53 Ibid.
54 Ibid.

and, if possible, journalists should also be provided with information. For this purpose, other United Nations bodies should be incorporated. Thus, in the long run, UNESCO should be incorporated in order to anchor technical progress in the 20th century (including nuclear energy) in the curricula of secondary schools.[55]

Based on these considerations, a list for a public acceptance programme was created:

1. Fairy tales and facts on Nuclear Energy including description of accidents
2. Publication of positive assessments on Nuclear Energy from outsiders
3. Increased rebuttals in technical literature (New Scientist etc…)
4. Increased reviews of reports (Club of Rome…) and Dissemination
5. Full use of UN media system (radio, press releases, UNCSTD, papers supplement)
6. Efforts to launch secondary school teacher's training on energy matters:
    a. approach to UNESCO
    b. to governments: Austria, FRG, Sweden
    c. summer schools training by IAEA
7. Better presentation of Agency's Annual Report
8. Prepare short factual rebuttal to Austrian "NO" arguments and disseminate
9. Increase information on comparative health costs and Env. aspects of Energy sources
10. IAEA/UNEP Panel
11. 1980 Agency Symposium
12. Include WHO
13. Increased participation by Agency staff in the preparation of information
    on the results of Agency's technical meetings (140 a year)
14. Increased Agency participation in meetings dealing with energy matters in general – an increased participation of environmentalism Agency meetings.
15. Planning for future Agency actions on specific subjects (decommissioning).[56]

From these points, a concrete plan of action was then developed, which was provided with a special budget of USD 87,155.[57] The Austrian nuclear programme ended thereby with a similar transnational knowledge transfer to the one it began with, and the Austrian experience was evaluated by the IAEA and was made available to its member states.

55 Ibid.
56 Ibid.
57 Ibid.

Facts & Figures

The purpose of this section is to give an overview of nuclear power in Austria. This section contains such data as number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization, and social connections to nuclear constructions. This data can be used as a supportive material to the following sections of the chapter and in order to understand the overall country's situation. Key dates and abbreviations used in this report are presented in the beginning of this section.

Data summary

- Austria projected three commercial nuclear power plants but had only one never operated nuclear power plant at Zwentendorf. The construction of new plants and start-up of the completed Zwentendorf NPP was abandoned in 1978 after a majority voted against nuclear power in a referendum.
- Austria has three small research reactors, two of them being decommissioned, and the other still being operated.

Key dates and abbreviations

Key dates

1910	Opening of the Institute for Radium Research as the first institut
1938	Annexation of Austria to Germany
1939s	Austrian physicists become members of the German Uranverein
1943	Merge of the Institute for Physics and parts of Institute for Radium Research into Four Year Plan Institute for Neutron Research under the Third Reich
from 1945	Liquidation of Four Year Plan Institute for Neutron Research and bring back university research institutions
1953	US-President Eisenhower's Atoms for Peace speech
1955	Austrian national sovereignty and decision to build a research reactor with American support
1955	Foundation of Österreichische Studiengesellschaft für Atomenergie
1958	Austria gets CERN membership
1955	Federal agreement for building and construction of the first research reactor

1960–1965	Three research reactors start operation (ASTRA, TRIGA and ARGONAUT)
1962	The second research reactor goes critical (TRIGA)
1965	The third reactor goes critical (ARGONAUT)
1971	Decision to build a nuclear power plant in Zwentendorf
1974	A new company established to build a second nuclear power plant
1977	International Conference for a Non-Nuclear Future in Salzburg. In the same year – public protests at Zwentendorf site and across Austria.
1978	Fuel is transported with the help of police and military helicopters to the Zwentendorf nuclear site.
1978	Majority of votes on public referendum against nuclear power (little difference). Zwentendorf reactor does not go online. Socialists' Party issues a law that prohibits use of nuclear power for generation of electricity.
1979	Three Mile Islands accident. Austrian society realizes wisdom of abandoning the nuclear power
1994	Study on decommissioning of the first research reactor (ASTRA)
1999	Constitutional law abandoning the use of nuclear power in Austria (BGBL 149)
1999	Shut down of the first research reactor (ASTRA)
2004	Shut down of the third research reactor (ARGONAUT) and decommissioning of the ASTRA reactor

Abbreviations

ASTRA	Adaptierter Schwimmbecken-Typ-Reaktor Austria (Adapted swimming pool-type reactor Austria)
AMF	American Machine and Foundry, Inc.
BGBL	Das Bundesgesetzblatt, Federal Law Gazette
BWR	Boiling Water Reactor
CERN	Conseil européen pour la recherche nucléaire
GKT	Gemeinschaftskraftwerk Tullnerfeld GmbH
NPP	Nuclear Power Plant
TRIGA	Training, Research, Isotopes, General Atomics – nuclear research reactors

List of reactors and technical and chronological details

The tables below show a summary of the nuclear research reactors and the only commercial reactor in Austria.

The previously Austrian Reactor Centre is now named Austrian Institute of Technology and the Atominstitut was renamed into Atomic Institute in Vienna. The Reactor Institute Graz was located at the University of Technology, Graz.

Table 1 – List of reactors in Austria

Name	Use	Operator	Supplier	Type	MWe net
Zwentendorf	commercial	GKT	AEG/KWU & Siemens	BWR	700
ASTRA, Seibersdorf	applied research	Austrian Reactor Centre	AMF	MTR	10
TRIGA	research, university trainings, education	Atominstitut TU Wien	General Atomics	Mark II	0.25
Argonaut	research, university trainings, education	The Reactor Institute TU Graz	Siemens	Argonaut	0.001

Table 2 – Key dates of reactors

Name	First talks	Construction began	Operations started	Shutdown	Decommission
Zwentendorf	earlier 1970	1972	never	1978	
ASTRA, Seibersdorf	1955	1958	1960	1999	2004
TRIGA	1955	1960s	1962		
Argonaut	1955	1960s	1965	2004	2004–2005

Periodization of nuclear development

The nuclear power development has three periods:

1 1910–1950: radioactivity research, several researchers are female. After the Annexation by Germany 1938, the number of women in research decreased by half and one fourth of all researchers lost their jobs. During the war Austrian nuclear physicists worked with German Uranium Club on nuclear fission.

2 1953–1970: After Atoms for Peace speech three research reactors were brought to operation with the aim of developing a nuclear energy programme in Austria. The main Austrian political parties – the Socialist Party and People's Party – were both pro-nuclear. The Liberal Party was a small opposition party that had critical views against nuclear power.

3 1970s–present: Building of the first nuclear power plant and referendum upon using the NPP. Rejection of nuclear energy in Austria.

References

There are several papers and books that treat radioactivity research and nuclear physics in Austria before WWII, but only very few publications that address the Austrian nuclear energy programme.

1. Literature on Austria before 1950
The most comprehensive work is the book of Silke Fengler (Fengler 2014). She analysed the Austrian research until the end of the 1940s including "denazification" and the reorganization of Austrian research. She edited also proceedings together with Carola Sachse, that give a broader view until the 1970s (Fengler and Sachse 2012). There are several papers by Wolfgang L. Reiter on Stefan Meyer (Reiter 2001b), the Nazi-era (Reiter 2004a; Reiter 2001a; Reiter 2004b), and the reorganization after 1945 (Reiter and Schurawitzki 2005). Maria Rentetzi published on the early period of radioactivity research in Vienna (Rentetzi 2005; Rentetzi 2009; Rentetzi 2004b; Rentetzi 2004a) until 1938.

2. Literature on Austria after 1950
Helmut Lackner (Lackner 2000) was the first, who treated the history from Atoms for Peace to the NPP in Zwentendorf. The most comprehensive work on this topic is my habilitation (Forstner 2016b), which was published at Springer Publishers in 2019 (Forstner 2019). Several papers by myself already appeared: Fengler and Forstner 2008; Forstner 2012b; Forstner 2011b; Forstner 2012a; Forstner 2011a; Forstner 2012b; Forstner 2016a.

There were several master theses at the University of Vienna focusing on different aspects of the Austrian nuclear programme. Most of them are available through the e-library of Vienna University (Premstaller 1997; Zehetgruber 1994; Schmidt 2007; Martinovsky 2012; Bayer 2013; Bayer 2014).

Bayer, Florian. 2013. *Politische Kultur, nationale Identität und Atomenergie. Die Österreichische Kernenergiekontroverse von 1978 bis 1986 im Lichte des Nationalrats.* Diplomarbeit, Universität Wien.

——. 2014. "Die Ablehnung der Kernenergie in Österreich. Ein Anti-Atom-Konsens als Errungenschaft einer sozialen Bewegung?" *Momentum Quarterly* 3:170–187.

Fengler, Silke. 2014. *Kerne, Kooperation und Konkurrenz. Kernforschung in Österreich im Internationalen Kontext* (1900–1950). Wien, Köln, Weimar: Böhlau Verlag.

Fengler, Silke, and Christian Forstner. 2008. "Austrian Nuclear Research 1900–1960. A Research Proposal." *Jahrbuch für Europäische Wissenschaftskultur* 4:267–276.

Fengler, Silke, and Carola Sachse. 2008. *Kernforschung in Österreich: Wandlungen eines interdisziplinären Forschungsfeldes 1900–1978.* Wien, Köln, Weimar: Böhlau-Verlag.

Forstner, Christian. 2011a. "From international Cooperation to the Failure of a National Program: The Austrian Case." In *A Comparative Study of European Nuclear Energy Programs,* ed. by Albert Presas i Puig, Berlin: Max-Planck-Institut für Wissenschaftsgeschichte, Preprint 498, 27–50.

——. 2011b. "Nuclear Energy Programs in Austria." *Jahrbuch für Europäische Wissenschaftskultur* 6:211–231.

——. 2012a. "Neutronenquellen - Von Atomzertrümmerung zu zerstörungsfreier Materialprüfung." In *Zur Geschichte von Forschungstechnologien. Generizität–Interstitialität–Transfer,* ed. by Klaus Hentschel, 140–160. Diepholz, Stuttgart, Berlin: GNT-Verlag.

——. 2012b. "Zur Geschichte der Österreichischen Kernenergieprogramme." In *Kernforschung in Österreich: Wandlungen eines interdisziplinären Forschungsfeldes 1900–1978,* ed. by Silke Fengler and Carola Sachse, 159–180. Wien, Köln, Weimar: Böhlau-Verlag.

——. 2016a. „Kernspaltung, Kalter Krieg und Österreichs Neutralität." In *Österreich im Kalten Krieg. Neue Forschungen im internationalen Kontext,* ed. by Maximilian Graf and Agnes Meisinger, 73–96. Göttingen: Vandenhoek und Ruprecht.

——. 2016b. *(Un-)Kontrollierbare Kettenreaktion? Kernphysikalische Wissensströme und Nukleartechnik im 20. Jahrhundert.* Habilitation, Friedrich-Schiller-Universität Jena.

——. 2019. *Kernphysik, Forschungsreaktoren und Atomenergie: Transnationale Wissensströme und das Scheitern einer Innovation.* Wiesbaden: Springer Spektrum.

Geden, Oliver. 1996. *Rechte Ökologie. Umweltschutz zwischen Emanzipation und Faschismus.* Berlin: Elefanten Press.

Hertel, Gerhard. 1998. *Die DVU – Gefahr von Rechtsaußen.* München: Hanns-Seidel-Stiftung.

Hewlett, Richard G., and Jack M. Holl. 1998. *Atoms for Peace and War, 1953–1961: Eisenhower and the Atomic Energy Commission.* Berkeley and Los Angeles: ACLS Humanities.

Karlik, Berta. 1950. "1938–1950", In *Festschrift Des Institutes für Radiumforschung anlässlich seines 40jährigen Bestandes (1910–1950),* 35–41. Wien: ÖAW.

Kremenak, Berta. 1948. *"Zur Frage der Genauigkeit der Radiumstandardpräparate* (12 December 1947)." Acta Physica Austriaca 2:299–311.

Krige, John. 2006. *American Hegemony and the Postwar Reconstruction of Science in Europe.* Cambridge, MA: MIT Press.

——. 2008. "The Peaceful Atom as Political Weapon: Euratom and American Foreign Policy in the late 1950s." *Historical Studies in the Natural Sciences* 38:5–44.

——. 2010. "Building the Arsenal of Knowledge." *Centaurus* 52:280–296.

Lackner, Helmut. 2000: "Von Seibersdorf bis Zwentendorf. Die 'friedliche Nutzung der Atomenergie, als Leitbild der Energiepolitik in Österreich." *Blätter Für Technikgeschichte* 62:201–226.

Lintner, Karl. 1949. *Wechselwirkung schneller Neutronen mit den schwersten stabilen Kernen (Hg, Tl, Bi und Pb).* Habilitation, Universität Wien.

Martinovsky, Julia. 2012. *Repräsentative Demokratie in Österreich am Beispiel der Volksabstimmung über das Kernkraftwerk Zwentendorf.* Diplomarbeit, Universität Wien.

Meyer, Stefan. 1945. "Über die Radium-Standard-Präparate (29. Nov./13. Dez. 1945)." *Anzeiger der Österreichischen Akademie der Wissenschaften, Math.-Naturwiss. Klasse,* 82:25–30.

Müller, Peter. 1977. *Atome, Zellen, Isotope: Die Seibersdorf-Story.* Wien, München: Jugend & Volk.

Premstaller, Florian. 1997. *Kernenergiepolitik in Österreich während der Ära Bruno Kreisky.* Diplomarbeit, Universität Wien.

Regler, Fritz. 1949. "Die Atomforschung und ihre Nutzanwendung in Österreich." *Die Industrie* 2:49.

Reiter, Wolfgang L. 2001a. "Die Vertreibung der Jüdischen Intelligenz: Verdopplung des Verlustes - 1938/1945." *Internationale Mathematische Nachrichten* 187:1–20.

——. 2001b. "Stefan Meyer: Pioneer of Radioactivity." *Physics in Perspective* 3:106–127.

——. 2004a. "Das Jahr 1938 und seine Folgen für die Naturwissenschaften an Österreichs Universitäten." In *Vertriebene Vernunft,* ed. by Friedrich Stadler, Bd. II:664–680. Münster: LIT-Verlag.

——. 2004b."Österreichische Wissenschaftsemigration am Beispiel des Instituts für Radiumforschung der Österreichischen Akademie für Wissenschaften." In *Vertriebene Vernunft,* ed. by Friedrich Stadler, II:709–29. Münster: LIT-Verlag.

Reiter, Wolfgang L., and Reinhard Schurawitzki. 2005." Über Brüche hinweg Kontinuität. Physik und Chemie an der Universität Wien nach 1945 – Eine erste Annäherung." *In Zukunft mit Altlasten: Die Universität Wien 1945–1955,* ed. by Margarete Grandner, Gernot Heiss, and Oliver Rathkolb, 236–259. Wien: Studienverlag.

Rentetzi, Maria. 2004a. "Gender, Politics, and Radioactivity Research in Interwar Vienna: The Case of the Institute for Radium Research." *ISIS* 95:359–393.

——. 2004b. "The City as a Context for Scientific Activity: Creating the Medizin-er-Viertel in Fin-de-Siècle Vienna." *Endeavour* 28 (1):39–44.

——. 2005. "Designing (for) a New Scientific Discipline: The Location and Architecture of the Institut für Radiumforschung in Early Twentieth-Century Vienna." *British Journal for the History of Science* 38:275–306.

——. 2009. *Trafficking Materials and Gendered. Research Practices: Radium Research in Early 20th Century Vienna.* New York: Columbia University Press.

Schaller, Christian. 1997. *Die österreichische Kernenergiekontroverse: Meinungsbildungs- und Entscheidungsfindungsprozesse mit besonderer Berücksichtigung der Auseinandersetzung um das Kernkraftwerk Zwentendorf bis 1981.* 2 Bde. Dissertation, Universität Salzburg.

Schmidt, Katharina. 2007. *Die Kernenergie-Debatte in Österreich. Analyse der politischen Auseinandersetzungen von Zwentendorf über Tschernobyl bis heute.* Diplomarbeit, Universität Wien.

Schwab, Günther. 1968. *Morgen holt dich der Teufel. Neues, Verschwiegenes und Verbotenes von der „friedlichen" Atomkernspaltung.* Salzburg, Stuttgart: Verlag „Das Bergland-Buch".

Straubinger, Johannes. 2009. *Sehnsucht Natur Bd. 2: Die Ökologisierung des Denkens.* Salzburg/Norderstedt: Book on Demand GmbH.

Walker, Mark. 1989. *German National Socialism and the Quest for Nuclear Power, 1939–1949.* Cambridge: Cambridge University Press.

——. 2007. "Eine Waffenschmiede? Kernwaffen- und Reaktorforschung am Kaiser-Wilhelm-Institut für Physik." In *Gemeinschaftsforschung, Bevollmächtigte und der Wissenstransfer. Die Rolle der Kaiser-Wilhelm-Gesellschaft im System kriegsrelevanter Forschung des Nationalsozialismus,* ed. by Helmut Maier, 352–394. Göttingen: Wallstein.

Zehetgruber, Andrea. 1994. *Die Geschichte des Kernkraftwerkes Zwentendorf von der Planung bis ins Jahr 1994.* Diplomarbeit, Universität Wien.

Jan-Henrik Meyer

"Atomkraft – Nej tak"[1]. How Denmark did not Introduce Commercial Nuclear Power Plants

Executive Summary

This chapter analyses the history of the relations between nuclear energy and society in Denmark. As in all of the chapters in this volume, the objective is to explain how these relations contributed to and shaped the development of the role of nuclear power in the country.

Even though Denmark was home to one of the pioneers of nuclear research, Niels Bohr, the country never introduced commercial nuclear power plants. Until the early 1970s, Denmark's development conformed to the general path among developed countries. The Danes participated in the Atoms for Peace campaign and attempted to develop their own reactor type. However, when its utilities attempted to finally introduce commercial nuclear power as a response to the oil crisis, Denmark took a different route. The decision not to "go nuclear" was taken in three steps:

First, in 1974, the Danish government proved very open to civil society concerns, advanced notably by the newly founded Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information, OOA), which organised the emerging anti-nuclear movement. The OOA demanded that the decision on nuclear power was to be taken by parliament, not simply by the relevant minister. They also called for postponing the decision, in order to allow for a public debate on energy policy more generally, as the oil crisis challenged Denmark's traditional reliance on imported oil. The government accepted this and made public funds available for a "debate on energy" to civil society via the Energioplysningsudvalget (Energy Information Committee).

1 „Atomkraft – Nej tak" – "Nuclear power – No thanks" – these words and the sticker were a key slogan of the Danish anti-nuclear movement, designed by the anti-nuclear activist Anne Lund (Lund and Breinholdt 1979). It politely, but clearly rejected the use of nuclear power. The sticker was translated into numerous languages and subsequently became the symbol of the global anti-nuclear movement. – The research conducted for this text is part of the HoNESt – History of Nuclear Energy and Society – Project. This project has received funding from the Euratom Research and Training Programme 2014–2018 under grant agreement no. 662268. The author would like to acknowledge helpful comments from project partners, the anonymous reviewers and the editor, and to express gratitude to the interviewees for their time and willingness to share their memories and recollections. I also would like to thank the Centre for Contemporary History, Potsdam, their directors Frank Bösch and Martin Sabrow, and the research unit led by Rüdiger Graf, for generously hosting me.

Second, in the summer of 1976, the Social-Democrat led government further delayed the decision to licence nuclear power plants, for two reasons: internal divisions within the party, as a consequence of the intense public debates about nuclear power, and adverse public opinion due to the well-organised campaigns of the Danish anti-nuclear movement.

Third, in 1985, the Danish parliament decided to exclude nuclear power from future energy planning. Changing positions within the political parties, adverse public opinion, and concerns about how to dispose of nuclear waste within Denmark informed this decision. However, Danish anti-nuclear activists continued to engage with nuclear power outside of Denmark. The Swedish nuclear power plant Barsebäck – near Copenhagen – remained the target of annual marches. After Chernobyl, the OOA started a campaign against "radiating neighbours", protesting against Swedish, West German and even East German reactors (Kaijser and Meyer 2018c). Most recently, public engagement with nuclear issues concerned nuclear waste from the research reactors and potential uranium mining in Greenland.

Three main analytical conclusions can be drawn, with a view to civil society and public debate, economy, and democracy and the perception of nuclear power and politics:

1. Civil society and public debate
   A well-organised and non-confrontational anti-nuclear movement highlighted the risks and potential problems of nuclear power in a small country, and managed to have a strong presence in an open, publicly supported "debate on energy", which influenced public opinion.
2. Economy and democracy: perceptions of nuclear power
   In the public debate of the 1970s, critics represented nuclear energy as contradicting the small-scale economic structures of Denmark. They further argued that the long-lasting impact of nuclear materials affecting future generations tested the limits of democratic decision-making.
3. Politics mattered
   Party politics and the divisions within parties and within the fragmented Danish party system mattered greatly for the political decision to reject nuclear power.

Narrative of the Historical Context

Introduction

Denmark was home to one of the great pioneers of nuclear research, Niels Bohr, whose lab played a pivotal role in nuclear fission research in the 1920s and 1930s. Bohr joined the United States Manhattan project during the Second World War (Nielsen et al. 1999, 64) and played an important role in the establishment of nuclear research in postwar Denmark, as influential chairman of the Atomic Energy Commission. Still, the country never moved towards the commercial use of nuclear power. Today nuclear power does not even feature as an option any more, and there is apparently great ignorance about it among younger people (Nielsen 2016). Indeed, it is indicative of Danish society's engagement with nuclear power that in a recent overview of Danish environmental history, the chapter on energy did not even mention nuclear power. Only the anti-nuclear sun – designed and spread world-wide by the Danish anti-nuclear movement – is presented in a section on environmental "action" (Fritzbøger 2014, 17–20, 32).

Until the early 1970s, Denmark's development, focusing mostly on nuclear research, conformed to the general path that many developed countries followed. This included the participation in the Atoms for Peace campaign, and the establishment of a state-funded nuclear research centre to develop its own national reactor type. However, in terms of introducing commercial nuclear power, Denmark was a rather late mover. Its main utility only went ahead with its nuclear plans in early 1974 – as a response to the oil crisis. This immediately sparked protests and controversy over the costs and benefits of nuclear power, which eventually led Denmark to take a different route. This is surprising, considering Denmark's extremely high dependence on imported oil, accounting for some 88 percent of Denmark's total energy supply in 1970 (Jamison et al. 1990, 90). Concerns about energy independence were indeed present in the public debate about energy in the 1970s. However, unlike domestic gas and wind power, nuclear energy's claim to making contribution to energy independence did not seem convincing to many critics, given that the technology and the enriched uranium fuel material had to be imported.

The decision *not* to "go nuclear" was effectively taken in three steps:

The first step was taken in 1974, when the Danish government responded to the critique by the emerging anti-nuclear movement led by the Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information, OOA), founded in early 1974. Not only did the OOA demand to put the decision on nuclear power in the hands of parliament, but also to delay the decision, in order to allow for a public debate on an issue, that – as OOA emphasised – would entail grave societal consequences (Jamison et al. 1990, 99).

The second step was taken in the summer of 1976, when the government led by the largely pro-nuclear Social Democrats under Prime Minister Anker Jørgensen decided to delay the decision to licence nuclear power plants. Two reasons motivated this decision: Against the backdrop of intense public debates about the consequences of building nuclear power plants, the Social Democratic Party became increasingly divided over the issue. Moreover, the government was facing an adverse public opinion (Villaume 2012) in part due to the active campaigns of the Danish anti-nuclear movement, led by the well-organised OOA (Mez and Ollrogge 1979/1981, Section 3.5). Concerns about the storage of nuclear waste also played a role.

Almost a decade later, on 29 March 1985, the Danish parliament – not the government – took the third step. Led by the Social Democrats, then in opposition, a left-leaning alternative majority decided to exclude nuclear power from future energy planning. In order to make the decision clearly irreversible, on 30 April 1985, the Danish parliament also withdrew the planning rights and claims to the sites foreseen for nuclear power plants (Sidenius 1986, 377).

However, mainly due to Denmark's geographical location, the history of societal engagement with nuclear power did not end with this domestic decision, but turned transnational. Located barely 20 km away from Copenhagen, the Swedish nuclear power plant Barsebäck remained the target of annual marches of the OOA together with Swedish protesters from 1976 onwards. Moreover, in April 1986 Denmark was affected by fallout from Chernobyl. In its "Radiating Neighbours" campaign the OOA lobbied the government to take international action on Barsebäck, but also on power plants in West and East Germany. An OOA delegation actually visited East Berlin in the October 1986 to protest against the East German reactors on the coast of the Baltic Sea (Meyer 2016, Kaijser and Meyer 2018c).

Emerging networks of nuclear research (1950s)

The early history of nuclear energy and society in Denmark conforms very much to the standard trajectory in Western Europe, and developed countries worldwide. From 1945 onwards, in the public sphere, all things nuclear were initially very much associated with the destructive forces of the "bomb" (Melosi 2013, 118).

However, from the mid-1950s – supported by the United-States-led Atoms for Peace campaign – an emerging network of institutions and researchers supported by the Danish state and by the United States government, sought to put a different spin on the nuclear issue. They highlighted the practically and economically useful aspects of harnessing the forces of the atom. Prominent among these uses was the possibility of generating electricity (Melosi 2013, 166–171). Event 1, below, will examine this process of engaging with the public in greater detail.

The development of nuclear energy in Denmark in the 1950s and 1960s was characterised by the establishment of relevant institutions and networks, efforts to develop nuclear research in a national setting at the Risø research establishment of the Danish Atomic Energy Commission (Risø 1968) – whose founding director was Niels Bohr –, and subsequently in transnational cooperation with a Swedish reactor project. These efforts mostly focused on basic research. As in many other countries this research was part of a quest to develop a "national" reactor type of its own (e.g. Switzerland (Wildi 2003), or Denmark (Nielsen et al. 1999)). In the Danish case, the goal of a national reactor was not only motivated by industrial policy and export aims, but by ideas of national self-sufficiency in uranium. The Danish reactor was to be fuelled with natural uranium from Danish Greenland (Knudsen and Nielsen 2016, Nielsen and Knudsen 2013). These technologically very ambitious projects failed, primarily due to a lack of resources for such a large-scale research and development task. Insufficient project management skills and experience among the Risø leadership played a role as well (Nielsen et al. 1999).

Engagement with the public did not feature very prominently in the 1950s and 1960s, except in the Atoms for Peace campaign. Civilian uses of nuclear power were linked to visions of a modern, positive, science-based future, and were not yet controversial.

Main actors

Who were the actors, who were part of an emerging network of promoters of utilising nuclear power in Denmark?

The central institution for developing nuclear energy was the Danish Atomic Energy Commission (Atomenergikommissionen, AEK), modelled on the American Atomic Energy Commission, and established by law in 1955 (Petersen 1996, 40). This institution emerged from the scientific establishment, the Danish Academy of Technical Sciences, with seed funding from a private foundation. The expressed aim was to participate in the Atoms for Peace programme and to obtain fissible material from the US to start nuclear research in Denmark.

While scientists took the initiative on the establishment of nuclear (research) institutions, support from the state, and by political actors proved extremely important, not least due to the high cost of nuclear research. In the 1950s and 1960s, the Danish Social Democrats were very receptive to requests from scientists. Across Scandinavian and European countries, postwar Social Democrats were highly committed to science and education as a path to modernisation, prosperity and welfare. Particularly the Social Democratic Finance Minister Viggo Kampmann, under whose auspices AEK was established, provided massive financial support to this new body's activities. In 1960, the expenditures of the AEK-administered Risø research centre accounted for 40 percent of overall Danish technological research spending across all technology research centres (Nielsen et al. 1999, 65–66).

While generously funded by the state, in its structure, the AEK remained dominated by scientists. Among its 24 members, ten were scientists from academic institutions, seven represented industry, only three were from utilities – the future users of the technology – and three from the labour unions. Personal connections mattered: the only high-ranking official who provided a link to government, Hans Henrik Koch, permanent secretary in the Ministry of Social Affairs, also happened to be a personal friend of Niels Bohr's, the chairman of the AEK until his death in 1963 (Nielsen et al. 1999, 66).

The generous funding and corporatist setup of the AEK ensured that it remained the central hub of what may be characterised as the emerging nuclear network in Denmark. Furthermore, the AEK was also in charge of the central research establishment for nuclear research in Denmark. The Risø research centre was established on a 250 hectare ground along Roskilde Fjord not far from Copenhagen. It officially opened on 6 June 1958 (Nielsen et al. 1999, 66), and subsequently acquired three research reactors.

Given the dominance of the AEK, utilities and industry played a more limited role as actors in the emerging nuclear sector. Despite the ongoing centralisation in the 1950s and 1960s, electricity provision in Denmark was relatively decentralised (Van der Vleuten and Raven 2006). There were only two larger players: Kraft-import, a body established in 1954 to import electricity from Sweden and to link between regional power grids and Elsam, which was founded in 1956 and integrated the grid for seven power stations in Jutland and Funen in the West of Denmark. These organisations subsequently became large enough to pursue nuclear plans by the early 1970s. As a federation of utilities, the association of Danish Electricity Providers (Danske Elvaerkers Forening, DEF), was the central association and lobbying body of the utilities.

Due to the small-scale structure of Danish industry, very few companies were interested in actively pursuing nuclear power technology. Some industrial companies from the metal industry, like Burmester & Wain and Helsingør Skibsværft, had know-how in outfitting power plants and providing boilers, and were thus interested to get their share of the cake of new power plant projects.

Despite the general interest in nuclear power, utilities' and industry's primary interest in reliable and cost-efficient power plants differed somewhat from that of the scientists at Risø. Hence, in order to have a say and to counterbalance Risø's monopoly on nuclear expertise, industry and utilities, led by the DEF, established Danatom to "help Danish industry and utilities with information on design and construction of nuclear reactors for generation of heat and power" (quoted in Nielsen et al. 1999, 69).

The development of nuclear research in Denmark did not lead to a nuclear power plant. The initial Danish reactor project of a Deuterium-moderated, Organic-cooled Reactor (DOR), to be run with uranium from Greenland, was abandoned in 1963. The Danish utilities were not interested in buying such a reactor, for a lack of demonstrable "economy and reliability" (Nielsen et al. 1999, 85). Subsequent cooperation projects with Swedish reactor development companies and attempts to devise a Nordic reactor equally failed. Thus when Elsam started to become interested in actually building nuclear power plants in 1971, they had to rely on imported nuclear technology. After a Canadian heavy water reactor that ran on natural uranium from Greenland could not provide the necessary safety documentation, the only option remaining were light water reactors relying on imported enriched uranium (ibid.) This put an end to any dreams of national self-sufficiency in uranium resources.

To the public, the Risø laboratory primarily presented itself in glossy brochures featuring images of their modern buildings and installations (Risø 1968). At a time when nuclear power remained mostly a vision, rather than a reality, and was hardly challenged, such a rather passive public relations strategy seemed appropriate. However, this changed in the 1970s, when nuclear power became more controversial. The new executive director Allan R. Mackintosh pursued a more active promotion of nuclear power. Risø researchers advocated nuclear power in the public sphere and refuted any criticism voiced by members of the public or the OOA (Nielsen et al. 1999, 86). This is discussed in greater detail in event 3 below.

With Risø's role as a provider of domestically-designed nuclear reactors dwindling, in 1967 it started taking over a new task. Apart from training nuclear engineers, gathering expertise in safety issues, in 1967 Risø was turned into the regulatory body for the implementation of nuclear power.

However, in the growing public debate about nuclear power, from 1973 onwards, Risø's problematic dual role of being an advocate of and a control body for nuclear power became increasingly apparent. Thus, in September 1973, a new regulatory institution was established, still under the auspices of the AEK, the Nuclear Inspectorate (Tilsynet med Nukleare Anlæg). The ten employees of the new Nuclear Inspection however still had their offices at Risø. This induced critics to continue raising objections concerning their independence (Nielsen et al. 1999, 83–84, Henningsen 2017).

Not going nuclear (1970s until present day)

Nuclear power rapidly became a controversial issue in the public when Elsam presented actual plans for the introduction of nuclear power in December 1973. Elsam had started studying various possible reactor sites for their suitability since 1971. Given Denmark's heavy reliance on imported oil, Elsam perceived building nuclear plants as the best available solution to combat rising fuel prices, and problems of providing fuel for its large number of oil-fired power plants, even more so after the start of the first oil crisis.

In the Danish parliament and in the public sphere, the existing Danish legislation concerning the licensing of nuclear installations was increasingly considered inadequate with a view to introducing much larger commercial nuclear power plants. Under the relevant law dating back to 1962 the Minister of Education could authorise power plants without any parliamentary involvement. It was in particular this rule that the anti-nuclear movement challenged (Petersen 1996, 169–171; OOA 1974).

By 1973/74, Danish society had increasingly become more politicised – in the wake of 1968, the referendum of October 1972 on the controversial issue of joining the European Community, and the December 1973 "landslide" elections, which had fragmented and reshuffled the Danish party system (Petersen 1996, 169–171, Hein Rasmussen 1997). Economically, the oil crisis hit Denmark hard. It was in this context that the central organisation of the Danish anti-nuclear movement, the OOA emerged.

The origins of the Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information, OOA) are somewhat coincidental. The organisation grew out of the activities of young Christians who got together for a three-day meeting in mid-June 1973 at the Danish section of the International Fellowship of Reconciliation (IFOR) in Lyngby in the North of Copenhagen. Those attending the meeting , including the student of theology Siegfried Christiansen, who was to become one of OOA's leading (transnational) activists (Meyer 2014, 229), explored internationally relevant issues that they would find worthwhile to devote their attention to. Their debate focused on what they considered urgent contemporary issues relating to peace or the fight against global inequality (Forsoningsforbundet and Christiansen 1973).

During the meeting – and clearly influenced by the group's internationalism, the contemporary debate on *The Limits to Growth* (Meadows et al. 1972) and the growing environmental concern in the wake of the Stockholm UN Conference on the Global Environment (Ecologist/FoE 1972) – they singled out growing energy consumption and the plans for nuclear power as particularly worrying developments. The young Christians voiced their concerns about what they considered problematic aspects of nuclear power. They highlighted radiation and other consequences of using nuclear fission – for the environment, but also for global peace and global inequality, and for subsequent generations – in terms of waste and the exploitation of natural resources. Against the backdrop of this discussion, they decided to campaign against nuclear power, which they considered the most "concrete" expression of their concerns about the pursuit of unlimited growth, that ignored its consequences for the environment and humanity (Forsoningsforbundet and Christiansen 1973, Christiansen 2017).

Since then, this group of mostly young people started organising and involving other groups critical of nuclear power. The Danish environmental organisation NOAH (Jamison et al. 1990) had also founded a group on nuclear power during the summer of 1973. This group included among others the science student Jørgen Steen Nielsen (Nielsen 2016), who later organised many of the activities against the Swedish nuclear power plant Barsebäck (Kaijser and Meyer 2018c). After being invited to a common meeting in August 1973, this group within NOAH joined forces with the young Christians. Subsequently also members of the Danish section of the Women's International League for Peace and Freedom (WILPF) and the Danish War Resisters International (WRI) joined the OOA[2] and founders started their activities by avidly collecting information – also from international sources – on nuclear issues, and met regularly until early 1974. When they eventually decided to set up an organisation, they chose a name which was deliberately neutral, to ensure a broad appeal and enhance credibility: Organisation for Nuclear Information – or more literally – for "enlightenment" about nuclear power (OOA 1974–1995).

On 31 January 1974, the newly founded OOA held its first press conference in Copenhagen, in response to Elsam's application for the licensing of new nuclear

2 Additional information on the groups involved in founding the OOA, which complements the sources consulted at the Rigsarkivet, was kindly provided by Siegfried Christiansen (Christiansen 2019b).

power plants. The organisation not only challenged the nuclear option, but it also called for an assessment of alternative energy sources. OOA's press release warned against what they considered an undemocratic and hastily taken decision. They criticised the licensing of the power plants by the minister as what in Danish was called a "panikbeslutning" (panic-induced, overly hasty decision) (OOA 1974). Instead, the OOA called for a period of reflection, of three years, in order "1. to examine the problems related to using nuclear power, 2. to do further research and assess again alternative energy sources, and 3. to develop a long-term energy policy, which takes ecological and social precautions" (OOA 1974). (My translation from the Danish original, JHM.)

The OOA called for a broad discussion of energy policy in the public sphere, rather than behind closed doors among experts. To them, energy policy was an issue of democratic, rather than technocratic decision-making. For reasons of democracy, they demanded that the licencing should be done by Parliament and not – as the old law of 1962 foresaw – by the minister of education. They also called for the provision of public funds for an information campaign on energy – in which both the promoters and critics of nuclear power would have a say (OOA 1974).

Indeed, the Danish parliament took decision-making about nuclear away from the minister and back into its own hands. It postponed the law about the authorisation of nuclear power plants in May 1974. On 12 June 1974, Minister of Commerce (Handelsminister) Nyboe Andersen, responded to the call for an open societal debate. He established the Energioplysningsudvalget (Energy Information Committee), after consultation with the Danish People's Information Council, a highly respected educational group active throughout the entire country. This body offered resources to those who intended to organise public discussions or meetings to inform people and to debate nuclear power (Petersen 1996, 169–171).

Opposition to the introduction of nuclear energy was clearly growing. OOA not only maintained a very effective central office, but also liaised with numerous grassroots branches all across the country. Decisions were taken by consensus in regularly held national meetings (landsmøder) for which members of the different groups came together (Christiansen 1977). OOA's campaigns evolved from an initial emphasis on encouraging discussion and information on nuclear power and energy policy more generally, to a more explicitly oppositional stance. In 1975, the OOA introduced the anti-nuclear sun stickers, politely but clearly declaring: "Nuclear power. No, thanks.", which subsequently spread worldwide (Christiansen 2017). In particular, near the construction sites of planned nuclear power plants, discussions were highly controversial. Opposition and protest were growing.

OOA groups used different instruments such as the collection of signatures. Near Søra on Vendsyssel on the northern tip of Jutland, and Gyllingnæs near Aarhus in Central Jutland 90 percent and 87 percent of the local populations (respectively) signed up against the power plant (Petersen 1996, 171–173). OOA however always remained non-partisan with a view to political parties and did not engage in violent protest (Nielsen 2016, Christiansen 1977, 2017).

National newspapers like *Politiken* and *Aktuelt* – that previously supported nuclear research – started to question nuclear power. The debate extended beyond the issue of nuclear energy. In the wake of the oil crisis, concerns raised by the influential Club of Rome about *The Limits to Growth* (Meadows et al. 1972) and the rise of environmentalism (Jamison et al. 1990), the societal debate considered the entire direction of energy policy in Denmark, including its growth-orientation and growing centralisation (on the issue of centralisation see: Van der Vleuten and Raven 2006). As a response to these debates, and the activities of the OOA (discussed in event 3, below), the Danish Atomic Energy Commission (AEK) was dissolved in 1976. The Danish government also decided to postpone the decision to licence nuclear power plants, until a solution to the problem of nuclear waste had been found (Nielsen et al. 1999, 85–87).

Protest and mobilisation continued, most notably against those nuclear power plants that "concerned" and "affected" Danes – as the contemporary parlance went (Milder 2010). These reactors were not located in Denmark, but nevertheless in the vicinity of Copenhagen, just across the Sound. The Swedish power plant at Barsebäck, which went critical in 1975, was the target of numerous marches organised by OOA from the 1970s until the 1990s. Not only protesters crossed borders: One reason for Barsebäck's location near Copenhagen was that this location facilitated supplying both the nearby Swedish cities and exporting electricity to Denmark. Indeed, OOA marched together with Swedish partners in transnational cooperation (Storm 2014, 53–55, 60, Kaijser and Meyer 2018c). Event 4 examines this phenomenon in greater detail.

In the face of growing and continued opposition and internal divisions within the Danish political parties, and responding to the fact that no suitable and convincing solution had been found to the issue of storing nuclear wastes, on 29 March 1985 in the Danish parliament a majority led by the Social Democrats (including other left-leaning and centre-left parties) decided to exclude nuclear power from the future Danish energy mix, and on 30 April 1985 to remove the reservations from planned construction sites (Sidenius 1986, 377).

The Danish nuclear energy debate of the 1970s was special, as it involved a massive societal engagement with energy policy more generally. This had an

Figure 1 Anti-nuclear protest in Denmark started out in 1976 with pan-Nordic marches against the Swedish Barsebäck plant. The photo from this march shows some of the main slogans in Swedish and Danish: "Nuclear Power? – No thanks"; "Against Barsebäck, 7 August 1976"; "Nuclear March; Every Nuclear Power Plant is a Plutonium Factory"; "Plutonium needs to be guarded for 100,000 years" which reflect some of the arguments underlying the critique of nuclear energy.

important effect on the long-term debate on nuclear as it spread throughout society knowledge on technical and economic issues on energy policy and nuclear power in particular, linking them to wider debates about the future of Danish society, such as concerning centralisation vs. the benefits of small-scale, renewable and regional energy provision (Petersen 1996, 176). In the course of one decade, the continued debate led to the political decision to exclude nuclear energy from Danish domestic energy production. The import of nuclear energy notably from Sweden as part of European networks continued, though. At the same time, the energy debate led to a pioneering role in the development of wind turbine technology, in which Denmark became a world leader (Heymann 1998). This also proved societally more acceptable, just as the use of gas and oil from the North Sea, because, as the contemporaries highlighted, it conformed to Danish traditions and structures of small-scale, regional energy provision (Van der Vleuten and Raven 2006).

In recent years, nuclear issues have re-emerged in Danish society, regarding two issues. First, the problem of dealing with the nuclear waste from the Risø research reactors emerged after the reactors were closed. Currently, the government is engaging in "Coordination and Communication with Stakeholders" (Denmark 2017, no page numbers) on this issue. Secondly, Denmark is involved in nuclear debates on uranium mining through its colonial heritage: even though Greenland has been granted home rule and it is not part of the European Union, the island is still a country of the Kingdom of Denmark. Thus the issue of uranium extraction, which is highly divisive within Greenland between those highlighting economic opportunities and those expecting of environmental harm notably with regard to fisheries that currently make up for 90 percent of Greenland's exports, affects political debates in Denmark, too. It is particularly controversial, as it seems to challenge the anti-nuclear consensus that emerged since the decision not to build commercial nuclear power plants in the 1980s. The title of a Danish newspaper article published in June 2016 in the context of debates and decisions in the Danish parliament aptly summarises what critics of nuclear power view as an apparent contradiction: "Once we said 'no thanks' to nuclear power, now Denmark will sell uranium." (Arnfred 2016, quote, no page numbers, my translation, JHM, see also, Walsh 2017, Nielsen and Knudsen 2013, Mavhunga and Trischler 2014, Knudsen and Nielsen 2016).

Events

As indicated above, with a view to commercial nuclear energy in Denmark itself the history of nuclear energy and society is much shorter than in most European countries, as Denmark never "went nuclear". However, the nuclear power plants built by neighbouring countries were an issue of public debate and protest in Denmark. Thus, societal engagement with nuclear power had a strong transnational dimension. These two insights inform the choice of events, along with the ambition to broadly cover different periods, and the availability of secondary literature and primary sources.

First, like in many Western publics, the campaigns of the Atoms for Peace initiative sought to promote the peaceful uses of nuclear technology in the 1950s. The second event – the activities of the Energy Information Committee 1974–76 – provides an exceptional example of public engagement. The Ministry of Commerce (Handelsministeriet) financed an information campaign on energy policy (including nuclear power) that was not top-down, but bottom-up, and included financial support for grassroots initiatives. This arrangement effectively prevented the dominance of pro-nuclear views. The third event is the struggle of experts in the media and public events in Denmark in the 1970s. This includes both opinion pieces and letters in major newspapers, written by advocates such as researchers from the nuclear research centre at Risø, and counter-experts, often from abroad, facilitated by the anti-nuclear movement. The fourth event relates to the long-drawn struggle of the Danish anti-nuclear movement against the Swedish nuclear power plant at Barsebäck, only 20 km away from Copenhagen (Kaijser and Meyer 2018c). The fifth and final event is the response of the Danish anti-nuclear movement to nuclear power projects in neighbouring countries, even on the other side of the iron curtain in the wake of Chernobyl in the late 1980s.

Event 1: Public information on energy and nuclear power in the 1950s: Great expectations

In the 1950s, the emerging nuclear energy sector, supported by many European governments and in particular the United States' government, tried to engage the public across Western countries (Melosi 2013, 166–171). At the time, in the minds of many citizens, all things nuclear were largely associated with its destructive forces epitomised by the nuclear bombs on Hiroshima and Nagasaki, and the subsequent nuclear weapons tests in far-flung places (Weart 1988). The international Atoms for Peace campaign (Krige 2006, 2010), kicked off by United States President Eisenhower in 1953 sought to change this image, and highlight the peaceful uses of nuclear power, such as in providing electricity at a competitive rate. In the United States, this campaign was conducted utilising the best available methods of public relations, including Disney's movie "Our Friend the Atom" and the accompanying book of 1956 (Haber 1956).

The first event to be discussed consists of two exhibitions in 1955 and 1957, respectively, that were both intended to promote nuclear power and celebrate the modern consumer society arriving in Denmark in the 1950s.

In Denmark, the United States-led Atoms for Peace campaign hit home with an exhibition "The Atom in Everyday Life" (Atomet i hverdagen) in the summer of 1955. Devised by the US Information Service (USIS) and also involving Danish nuclear scientists, the exhibition was shown in Denmark's largest cities, Copenhagen, Aarhus and Odense. The exhibition attracted some 140,000 people and 190,000 pamphlets were distributed. Opinion polls conducted after the exhibition demonstrated that 84 per cent of the respondents had "heard or read of any peaceful, non-military purposes of atomic energy" and a large majority of respondents held a positive view of atomic energy (Christensen 2002, 95).

The United States targeted Denmark, and the country's energy policy, also for Cold War security reasons. Ideas of neutralism were traditionally popular in the country, even though it was part of NATO. Neutrality would have potentially endangered the US presence in Greenland, a place of strategic relevance in the Cold War (Petersen 2013). Moreover, in terms of energy provision, Denmark was highly reliant on coal from the Eastern bloc, particularly Poland, thus making it potentially responsive to political and economic pressures from the East (Nielsen and Knudsen 2010, 96).

While the first exhibition was part of the international Atoms for Peace campaign and thus a transnational intervention in Denmark, a second exhibition, two years later, was more home-grown: "Live your life the electric way!" The poster for the "International Electric and Nuclear (literally 'Atom') Exhibition" in Copenhagen in October 1957 promoted all the advantages of the modern life and the convenience of the new electrical appliances that became available during the postwar boom. Nuclear energy was shown to provide the "cheap" and readily available electricity needed for a more convenient way of life. The exhibition fit well into what is usually considered the spirit of the time, a preoccupation with modernity and with the promotion of technological advances in the 1950s. Indeed, at the time, Danish consumer society was on the rise. Growth rates of electrical energy consumption in Denmark, which had been one of the lowest in Europe back in the early 1950s, were among the highest by 1957 (Petersen 1996, 112–115). This made energy planners think of alternative sources to imported coal. From the late 1950s until 1973, however, cheap imported oil from the Middle East provided an ample and inexpensive fuel for the postwar boom (Pfister 2010). Similar to the situation in various other Western countries at the time, this substantially reduced the appetite for nuclear power until the oil crisis.

The 1957 exhibition, which was open for 10 days only, attracted 134,515 visitors (Petersen 1996, 112). A poster advertising the event nicely illustrates the spirit and imagery of celebrating science and modernity (printed off in: Petersen 1996, 113). The exhibitions did not directly lead to any decision on nuclear power. Nevertheless, they were part of the public relations campaigns that accompanied the introduction of nuclear research to Denmark and the founding of the Risø research establishment, with its eventually three research reactors (discussed above).

The event's importance was not widely recognised at the time. Indeed, I selected the event in retrospect, in line with the conventions of a nuclear historiography that tends to stress the importance of the Atoms for Peace campaign. At the same time, the actors involved, such as the cultural attaché of the American embassy, of course highlighted the importance of their own actions and their impact on the course of history:

> It [the exhibition] came here at a most opportune time, as we all know, Denmark just recently embarked upon a programme of all-out support for developing the potentials of nuclear energy. To what extent President Eisenhower's Atoms for Peace proposal has something to do with these Danish developments cannot be determined. But I would not be surprised if there were some loose, hard-to-defined causal relations between the two – something in the nature of a mild chain-reaction…
> (quoted after: Nielsen and Knudsen 2010, 96).

A detailed and systematic analysis of these two events is provided subsequently: It focuses (1) on the various actors involved in nuclear-societal relations; (2) on practices and problems of public engagement with nuclear energy; and (3) on arguments various actors made about nuclear power as well as these actors' behaviour.[3]

Event analysis 1:
Public information on energy and nuclear power in the 1950s: Great expectations

For the analysis, two real-world events were viewed in conjunction:

First, the exhibition "The Atom in Everyday Life" (Atomet i hverdagen), was to demonstrate the potential uses of nuclear applications. In the summer of 1955, the exhibition travelled to Copenhagen, Aarhus, Odense, thus Denmark's largest cities and metropolitan areas in the different parts of the country. Secondly, the "International Electric and Nuclear (literally 'Atom') Exhibition" in October 1957, presented electrical appliances and their practical use in the household. Nuclear power was shown in models and drawings that demonstrate how nuclear power serves to produce electricity. The exhibition took place on 18–27 October 1957 in Copenhagen.

3 The analysis of the event was structured in response to a set of questions and terminology devised in interdisciplinary cooperation within the HoNESt-History of Nuclear Energy and Society Project. These questions regard. the event itself, the actors involved (including their alliances, conflicts, transnational cooperation, mutual trust), public engagement (ranging from communication to consultation and even participation) and arguments and behaviour (including an analysis of narratives and communication by different actors, but also violence). The detailed set of research questions posed can be found online at: http://www.honest2020.eu/sites/default/files/deliverables_24/DK.pdf (22 et seq., last accessed 21 October 2019).

Actors

Who were the main actors for and against nuclear energy involved in the event and what were their political connections? The promoters of nuclear energy enjoyed full government support in the 1950s. In the case of the first exhibition, this promotion of the nuclear cause involved both Danish national government as well as Cold War style transnational US government intervention via the United States information service (USIS). Further support was provided by a Danish state-funded scientific body, namely by researchers from the budding Risø research establishment set up to develop and promote nuclear power.

In the case of the second exhibition, companies and businesses presented themselves as the main promoters of a nuclear future. This included the Danish electricity provider, Danatom, a private company, for the commercial exploitation of nuclear energy, founded in 1956, and again, the Risø research establishment. It also encompassed associations set up to promote and implement nuclear power, namely the Danish Atomic Energy Commission (AEK) and Danish industry associations.

At the time, a close-knit network emerged among those involved in the new technology in Denmark, which extended towards the United States. The US were the technological leader in the Western World, providing state of the art technological, scientific and PR know-how, as well as organisational models for institutionalising the promotion of nuclear energy effectively, notably through an Atomic Energy Commission (AEK).

To what extent the events and the involvement of state and private actors changed trust and public opinion concerning nuclear energy is difficult to establish given the limited information available. Poll data (mentioned above, Christensen 2002, 95) only suggest growing familiarity with the issue of nuclear power, and a majority holding a positive view, which the organisers of the event self-confidently attributed to their own actions.

Public Engagement

The type of public engagement employed at this event can best be characterised as a public communication process, with information being disseminated and conveyed to a public, in a top-down communication process, relying on commercial advertising techniques, and the exhibition of nuclear and electrical energy and appliances. The events were initiated by the promoters of nuclear power, who at the same time advocated economic progress and the advantages of a consumer society involving electric appliances. They made use of displays and the distribution of information materials.

During these events, the interaction between the "promoters" and the potentially "affected" people was rather limited. The visitors of the exhibition remained passive recipients who were to be taught a lesson they were expected to accept. The organisers sought to evaluate the events through opinion polls, which demonstrated an increase in knowledge about and support for nuclear power that the promoters considered a success (Nielsen and Knudsen 2010, 96).

Arguments and Behaviour

In the second half of the 1950s, there was no explicit conflict about nuclear power and its use. Unlike atomic weapons, nuclear energy was largely uncontroversial at the time, in the wake of the Atoms for Peace campaign. However, texts and speakers implicitly anticipated (critical) arguments about nuclear fission's destructive potential in military technology that citizens were familiar with.

Available sources only provide information on the behaviour and the discourse of the promoters of nuclear energy, not of – at time only potentially – affected populations. We can assume that many of the visitors of the exhibitions broadly accepted and tolerated what they were shown. The events thus provided a forum for a promoter narrative of progress, prosperity and of a convenient modern life. What was subtly and implicitly promoted was the expectation that nuclear energy – and its concomitant benefits – were soon to be introduced in Denmark.

Veteran Danish nuclear scientist Niels Bohr, a hero and key promoter of the nuclear age, emphasised a number of themes in the introduction to the exhibition's catalogue (Petersen 1996, 112–115). The availability of enormous amounts of energy provided by nuclear power meant new perspectives for society and the economy. He emphasised the great challenges the new technology posed to industry and science, and the need to inform a broader population of these challenges and their contribution to society.

How did government behave towards nuclear energy? The Danish government supported nuclear research with a view to scientific "progress", national ambition and economic growth, and framed nuclear along these lines. Civil-nuclear interactions include curiosity on the part of the citizens and top-down communication from international bodies, the research community and – along with it – the government.

Event 2 / Showcase: The Energioplysningsudvalget (Energy Information Committee): a public information initiative 1974–1976.

As a response to the oil crisis, in 1973 the Danish utility Elsam submitted plans to build nuclear power plants. In dealing with the issue of licensing, the Danish parliament took an important decision. Instead of giving full support to these plans, under pressure from growing protest of the newly founded, but very active Organisationen til Oplysning om Atomkraft (Organisation for Nuclear Information) (OOA 1974), it decided to postpone the decision in the summer of 1974, and take time for public engagement and debate about the future of Denmark's energy provision.

Thus, members of the Danish parliament accepted the OOA's claim that more public information and debate on the advantages and disadvantages of nuclear power were necessary. The Ministry of Commerce (Handelsministeriet) set up the Energioplysningsudvalget (Committee on Energy Information). This body was to organise debates via educational institutions, in part to depoliticise the issue and turn it into an issue of knowledge and education. It offered grants to groups and organisations applying and money to fund information meetings, discussion groups, or to invite foreign experts on nuclear power (Geertsen 1974–1976). Trade Minister Nyboe Andersen set up the Energioplysningsudvalget, after consultation with the Danish Council for People's Information (Dansk Folkeoplysningssamrådet), the country's highly respected institution of further education. It was administered by Uffe Geertsen, whose background was in engineering, which he taught at a people's "high school" (højskole – further education institution). Thus, the Energioplysningsudvalget became linked with those local educational organisations, which were part of the people's high school movement. Founded in an age of educational reform in the 19th century, the people's high schools were well-established in public education in Denmark. They are a Danish particularity, offering elements of post-secondary education to everyone, and enjoyed enormous esteem for their work in informing and engaging with citizens (Mejlgaard 2009, 487–488). Rather than relying on state-of-the-art public relations, as in the Atoms for Peace campaign of the 1950s, the Energioplysningsudvalget's work was to be conducted in a grassroots manner (Petersen 1996, 170–171). Citizens and societal groups could apply for funding to organise "meetings, study circles, exhibitions or other information activities". The Energioplysningsudvalget offered "recommendations of possible topics for study circles, evening lectures or debates", they sent out "lists of relevant literature and films, slides and exhibition materials", and for "presenters and study circle teachers". Finally, they prepared a hands-on, practically-minded project on "the energy-right town" (energi-rigtig by) to improve energy efficiency at the local level. Promoting public science and public technology (Trischler and Bud 2019) "avant la lettre", they provided funds for citizens to explore energy consumption and potential energy savings and improvements in energy provision and consumption in their own town (Energioplysningsudvalget 1975b). Groups from the high school movement involved in these activities not only advanced the debate about energy across Denmark, but also started searching for alternative sources of energy. These groups contributed subsequently to the very successful development of reliable and efficient wind turbines in Denmark in the latter half of the 1970s (Rüdiger 2014, Heymann 1998).

The Energioplysningsudvalget not only funded events and public meetings, it also published a six volume book series on energy policy, in which the pros and cons of the different existing and potential future energy resources were comprehensively discussed. The editors aimed at a well-balanced presentation of all the arguments at hand and at an account that was comprehensible for non-experts (Henriksen 1975, Geertsen 1975b). The second book of the series was entirely devoted to nuclear power, presenting the views of different actors, including labour unions, utilities, industry and consumers. The nuclear issue was also mentioned throughout the other volumes (Geertsen, Henriksen, et al. 1975, Geertsen, Algreen-Ussing, et al. 1975, Geertsen 1975a, Energioplysningsudvalget 1975a, Degnbol et al. 1975, Bondesen et al. 1975).

The Energioplysningsudvalget as an event did not directly lead to any decision. However, in the wake of the two years' process of debate on energy, the controversy about and growing opposition to nuclear power (also reflected in poll data, Villaume 2012) clearly informed the Danish government's decision not to go ahead with nuclear energy in 1976 (see discussion above). I chose the event as an exceptional example of grassroots, but state-sponsored engagement, with very few strings attached. The event itself was not recognised so much by the contemporaries as "historical", nevertheless as an important national exercise at a turning point in energy policy (Geertsen 1975b), after the end of cheap imported oil. The event is not very much recognised in subsequent debates. Some of the historical overviews on the issue of nuclear energy policy do not even mention it (Villaume 2012).

Event Analysis 2: The Energioplysningsudvalget 1974–76 – a public information initiative, which sponsored grassroots initiatives' information and engagement activities on energy policy including nuclear power

Actors

The Energioplysningsudvalget was a state-sponsored office, a large number of publicly funded events and public consultation on nuclear energy, and also the name of the funding instrument. These events were to be organised by grassroots and public education groups. The Danish anti-nuclear organisation OOA was not excluded. The Energioplysningsudvalget head office also published a book series on energy issues (Geertsen, Henriksen, et al. 1975, Geertsen, Algreen-Ussing, et al. 1975, Geertsen 1975a, Energioplysningsudvalget 1975a, Degnbol et al. 1975, Bondesen et al. 1975).

The promoters of nuclear energy involved in the public debate can be divided into different groups and categories. These include companies (some of them publicly owned) like the utility Elsam, which planned to build four nuclear power plants, and its director E.L. Jacobsen (Jacobsen 1975), who contributed to one of the books published by the Energioplysningsudvalget. Scientific institutions and scientists were also involved. Researchers from the state-funded Risø research establishment, such as C.U. Linderstrøm-Lang co-authored overview of the nuclear issue within the book on nuclear power (Linderstrøm-Lang and Meyer 1975), as were researchers from the Niels Bohr Institute (Elbæk 1975). Various associations participated in the debate, such as the Danish Atomic Energy Commission (AEK, Atomenergikommission). One of its members, Henning Sørensen, a physicist, for instance advocated the use and the ready availability of uranium from Danish Greenland (Sørensen 1975). Representatives of Danish industry (Foss 1975) were generally supportive, but not uncritically so. Interest organisations including labour unions equally participated in the debate (Møller 1975).

A new interest organisation was founded in 1976 – with support from Risø and the Niels Bohr Institute (Elbæk 1975) – namely, the pro-nuclear association Real Energy Information (Reel Energi Oplysning, REO) (Villaume 2012). Among political parties, especially individual party members voiced their view in the nuclear debate, like Social Democratic MP Morten Lange, who, in 1976, considered opponents to nuclear power as driven by “religious zeal” and “emotions” (Villaume 2012). In the media, local and more conservative newspapers (including *Berlingske Tidinge*) supported nuclear power at the time (Villaume 2012).

If so called receptors or affected people participated in the debate, then most were sceptical about nuclear power, or outright opposing. Among those critical of excessive pro-nuclear enthusiasm were also representatives of science. For instance, the co-author of the overview of the nuclear issue within Energioplysningsudvalget's book on nuclear power was Professor Niels I. Meyer from Denmark's Tekniske Hogskole (Danish Institute of Technology). Meyer took a nuanced critical position (Linderstrøm-Lang and Meyer 1975).

With the founding of the OOA, the critics of nuclear power had formed an increasingly effective interest organisation or social movement organisation. Members of OOA such as Siegfried Christiansen (1975) contributed to the Energioplysningsudvalget's books. OOA's local groups also organised events and very actively drew on Energioplysningsudvalget's money (Geertsen 1974–1976). Educational groups from the Danish Council for People's Information (Dansk Folkeoplysningssamrådet) and from the people's high school (højskole) movement organised events, drawing on and benefitting from the funding from the Energioplysningsudvalget (Geertsen 1974–1976). From the perspective of the research mobilisation theory in the study of social movements (Jenkins 1983, Edwards and McCarthy 2007), this should have greatly helped the budding OOA.

Political connections and the opportunities for political influence they provide have been highlighted as decisive in the politics of nuclear power by a second theory of social movements, namely the theory of political opportunity structures (Kriesi 2007, Kitschelt 1986, Kolb 2007). Initially, the pro-nuclear actors enjoyed substantial state and government support. However, since the public debates of the Energioplysningsudvalget, this support was waning, as the Social Democrats in particular were increasingly facing opposition and polls indicating the diminishing enthusiasm for nuclear energy among the general public. The party became more divided on the issue. Individual Social Democrats, like above-mentioned Morten Lange, continued to publicly defend nuclear power as the energy of the future, which had been a prominent argument since the 1950s (see the analysis of the first event in this chapter). Interestingly enough, within scientific bodies, but also across different associations and groups, there was substantial pluralism, no uniform commitment to nuclear power, but a rather open search for the most suitable and (in the long run) least expensive solution to Denmark's energy dilemma.

The OOA thus benefitted from increasingly receptive political opportunity structures and in particular the resources made available for "nuclear information" via the Energioplysningsudvalget. Hence, notably among the pro-nuclear conservative people's party in parliament, the activities sponsored by the information committee were increasingly perceived as state-funded support for anti-nuclear activism. While the Social Democrats defended the Energioplysningsudvalget in the debate, they did not continue its funding for another year (Petersen 1996, 171).

Hence the activities of the Energioplysningsudvalget did not develop into a longer-term exercise of public engagement. Nevertheless, between 1974 and 1976 they had reached and involved some 150,000 Danes, thus approximately 3 percent of the total population of slightly more than 5 million people in 1976.

To what extent networks and alliances of actors were forming and played a role is hard to establish, as the societal cleavage concerning nuclear power was only emerging at the time. Clearly, the book projects, and the various events offered plenty of potential for informal network building. International involvement and transnational exchange, such as the invitation of foreign (counter-)experts (see next event) was greatly facilitated by the sponsorship available through the Energioplysningsudvalget.

There were also alliances involving political parties, scientific bodies, and utilities, on the pro-nuclear side: The pro-nuclear organisation REO was established linking the venstre partiet's energy commission, actors from the Risø research centre (Per Brøns, O. Walmød-Larsen), from Elsam (Søren Mehlsen) and from the Niels Bohr Institute (Prof. Bent Elbek) (Elbæk 1975). The organisation only had a membership of 1100 people and associations (by 1978), which ensured substantial funding (340,000 DKK in 1977) (Petersen 1996, 176–177).

The rules for authorising and regulating nuclear power plants were controversially discussed at this time, including the role of the Atomic Energy Commission and Risø as the future regulators of nuclear power plants and the relevant laws were changed to improve independent regulation of nuclear facilities (Henningsen 2017, Christiansen 2017).

Public debates in the context of the Energi oplysnings udvalget impacted on public opinion and trust, through the involvement of various actors in the debate. This fostered a more comprehensive understanding of nuclear power, and a loss of naive, uninformed trust in its potential benefits.

Public Engagement

The events and publications of the Energioplysningsudvalget provided for more than just one-way communication or simple consultation. In fact, through their grassroots organisation and multiplicity of formats they allowed for participation, too. Frequently, they were initiated by groups of affected citizens. At the time, it was not altogether clear whether they would turn into opponents. Often the events financed involved talks by experts and counter-experts, but also discussions among the participants themselves on various issues of energy policy, for instance during a weekend seminar, organised by a civic education group. Such events frequently involved a lot of interaction.

While there was state funding, the individual events sponsored by the Energioplysningsudvalget were organised by grassroots groups – including local OOA groups. The kinds of events included discussion groups, weekend seminars, or talks of invited experts.

The interaction between proponents and opponents in the book projects demonstrates considerable respect for the position of the other one, and involved cooperation. For the events, it is hard to reconstruct exactly how the proponents and opponents interacted, and how seriously they took citizens' concerns, as there are no detailed records of these meetings available in the archives, that would allow for a thorough analysis the engagement process. The events were not formally evaluated, only the numbers of participants were tracked.

Arguments and Behaviour

The decisions of the Danish Parliament and of the Ministry of Commerce allowed for a wide, open, and multi-faceted debate, by funding events organised by a variety of educational bodies, including anti-nuclear groups. This allowed for a level playing field between the pro- and anti-nuclear side, which was unique at the time. Via its institutional funding, for instance, the research centre at Risø had long had resources available for communicating with the public, for instance through information leaflets (Risø 1958).

There was substantial conflict about the issue of introducing nuclear power to Denmark, however, unlike in other countries, such as France or Germany (Tompkins 2016, chapter 5), no violence or use of force. At this stage, the information campaign involved discussions and public information, within schools, weekend retreats, educational centres, rather than protest and taking the streets.

Parts of the government, as well as the utility Elsam, supported the introduction of nuclear power in Denmark, as did the Risø nuclear research centre. They argued in favour of nuclear as an alternative energy source after the end of cheap oil. Initially, there was a great deal of acceptance and tolerance within society. Many critics argued that this was due to a lack of knowledge. Indeed, a search of library catalogues indicates that there is little to no evidence of publications in Danish on nuclear energy before 1974. Even the first book by the promoters of nuclear energy only appeared in 1974, and its authors found it important to highlight that this actually was the first publication on the issue of nuclear energy, and that it responded to the beginning of the debate in 1973/74 (Korsbech and Ølgaard 1974, 7–9).

Basically, the main issues of the debate at the time were the following, as highlighted by the authors of the Energioplysningsudvalget's relevant publication (Linderstrøm-Lang and Meyer 1975, 12–18):

Arguments in favour of nuclear energy included:
- Security of supply and low cost: Nuclear power would ensure cheap and reliable energy provision in the face of rising oil prices and problems of availability.
- No alternatives: There was a lack of alternatives to nuclear energy: with growing consumption, and the end of cheap oil, nuclear seemed the only option available.
- Trust in technology arguments, notably:
  - Low risk of accidents: the supposedly low probability of nuclear accidents,
  - Technology provides safety: the assumption that, with growing technological knowledge, they could be prevented more effectively.
  - Nuclear waste: Technical solutions available in the future would solve the nuclear waste problem.

Arguments against nuclear power included:
- Nuclear waste: The most important critical issue was the problem of nuclear waste, where to store it and the need to protect it for a very long time.
- The risk of accidents and the large-scale damages that such accidents might involve also featured importantly in the debate.
- The societal consequences of nuclear power, with a view to societal structures and democracy were equally discussed. The central argument about the impact on society ran as follows. For safety reasons, the use of nuclear power would

require imposing strict protection of nuclear installations, centralising decision making and economic power. This argument about a looming nuclear quasi-dictatorship reflects what the Austrian author Robert Jungk subsequently described as the "nuclear state" ("Atomstaat") in his 1977 book (Jungk 1984 [1977], 1977).[4] Rather than centralising, and committing to ever larger structures, critics demanded that society should opt for local small-scale energy provision. This in turn proved an argument in favour of renewable energy sources as an alternative to nuclear power and oil, which were explored in the 6th volume of the book series of the Energioplysningsudvalget (Danielsen et al. 1975, see also: Meyer 2018) and advocated also by the OOA as early as 1975 (OOA 1975)
– *The Limits to Growth* (Meadows et al. 1972) argument. The Club of Rome had argued that endless growth was not possible. Thus the way forward should be by energy saving and moving towards renewables.
– What could be called the "It's the society, stupid" argument runs as follows: The long-term societal implications of nuclear power were so grave, that these issues were for society, not for technocrats, to decide, because it tested the limits of democracy (Nielsen 2016).

The debate of the 1970s can best be illustrated by the "stickers' war" between three different Danish associations, active in the discussion on Denmark's future energy provision:
– The Organisation for Nuclear Information, OOA (rejecting nuclear power, "no, thanks"), they discontinued their work in 2000.
– The Organisation for Renewable Energy OVE (Organisationen for Vedvarende Energi), advocating "sustainable (vedvarende)" energy which had emerged in the context of OOA in 1975, and is today called Vedvarende Energi. The association Real Energy Information REO (advocating nuclear power, "hvad ellers?", "what else?"). Founded in 1976, since 2012 they are called Ren Energi Oplysning (Clean Energy Information), advocating nuclear energy as CO2-free. Accordingly their present-day sticker says: "Atomkraft – CO2-fri energi", encircling a green heart-shaped nuclear symbol.[5]

4 Jungk was actually among those experts the OOA invited to Denmark in 1979 (see next section).
5 The current logo can be viewed at: http://www.reo.dk (last accessed 7 November 2019), the historical sticker is available at http://denstoredanske.dk/@api/deki/files/83318/=bd-15-102.jpg?size=webview (last accessed 7 November 2019).

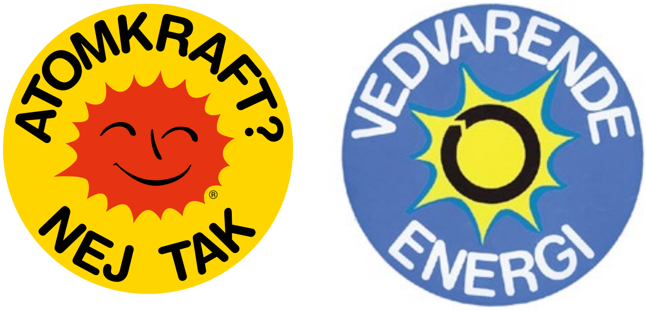


Figure 2 The "Smiling Sun"-logo was designed by the activist student Anne Lund from Aarhus in 1975. The Danish anti-nuclear organisation OOA reserved the copyright and used the proceeds from selling the polite logo "Nuclear Energy – No thanks" internationally to generate revenue – also to support international cooperation.

Event 3: The struggle of experts conducted in Danish newspapers among pro-experts from Risø vs. anti-nuclear activists and counter-experts from abroad (1970s)

Controversies about modern environmental issues tend to rely heavily on scientific and technical expertise (Sörlin 2013, Warde, Robin, and Sörlin 2018, 15–16). This also holds for nuclear debates – as examples from various countries demonstrate (Topçu 2008, Weish 2013). In the discussion about the introduction of nuclear power in Denmark from 1974 onwards, both sides heavily drew on experts. The advocates of nuclear energy relied on their own technical and scientific expertise, available notably at the nuclear research centre at Risø. By contrast, the OOA invited various counter-experts from abroad, to give talks and to participate in public discussions, challenging public authorities to engage with the issue. The list of anti-nuclear experts invited – presented below – reads like the "who's who" of international nuclear critics, and demonstrates the excellent transnational connections the OOA established from its very beginnings.

By bringing in these experts, OOA sought to benefit from the key resources they provided (Edwards and McCarthy 2007), notably scientific credibility, prestige and legitimacy. For instance, on a poster advertising an "evening debate" on

22 April 1976 on "Nuclear energy – putting the future at stake", Hannes Alfvén was presented as "Swedish physicist, professor and Nobel Prize winner". His more political role as "the pioneer of global nuclear critique" only came second (OOA 1976, no page numbers). Furthermore, foreign experts were often invited, since they were not part of the domestic conflict, and thus enjoyed greater credibility (Weish 2013).

Figure 3 The mobilisation of foreign experts: "Swedish nuclear physicist, professor and Nobel Prize winner Hannes Alfven, 22 April 1976", by the Danish anti-nuclear organisation OOA. Poster "Evening debate: Nuclear energy – putting the future at stake – with the 'pioneer of global critique of nuclear power'", sticker bottom right: "Do you have trust in nuclear power?"

At the same time, advocates of nuclear energy, engaged in campaigns in newspapers, writing book reviews, opinion pieces and letters to the editor, challenged the scientific credibility of the experts the OOA presented. Among them, Risø engineer Heinz Hansen (OOA 1974–1989), a founding member of the pro-nuclear REO (Oplysning 2016), was one of the most active pro-nuclear experts.

The evening events are actually a series of events or a continuous event. It can only be loosely linked to the decision of the government to postpone the introduction of nuclear power, as the debate involving experts extended beyond that 1976 decision well into the late 1970s. Thereafter the invitation of counter-experts however became less frequent.

These events were covered by the media – or actually took place within the media's comment pages or letters to the editor. Hence a certain contemporary relevance in the public sphere can be assumed. None of these events were considered historical, or became a point of reference, neither then, nor in retrospect.

The following list of events with foreign experts the OOA organised between 1973 and 1991 draws on the files of the OOA (OOA 1973–1980). It illustrates the transnational connection of the OOA and its ability to invite prominent experts, mostly from abroad:

Date	Invited Expert	Location
21-11-1973	Björn Gillberg	Copenhagen
14-12-1973	Dean Abrahamson	Lyngby
16-04-1974	Thorkild Bjørnvig	
	Ove Nathan	Copenhagen
21-05-1974	Björn Gillberg	
	Arthur Tamplin	Copenhagen
26-10-1974	Myron Cherry	Copenhagen
28-11-1974	Dean Abrahamson	Copenhagen
02-03-1975	Henry Kendall	Copenhagen
28-04-1975	Amory Lovins	Copenhagen
22-04-1976	Hannes Alfvén	Copenhagen
22-04-1977	Dean Abrahamson	Copenhagen
25 till 27-04-1977	Amory Lovins	Lyngby
10-05-1975	Heldagsmøde Alternative Energikilder (One-day meeting on alternative energy resources, various speakers)	Copenhagen

Date	Invited Expert	Location
13-06-1977	Robert Pollard	Copenhagen
27-01-1978	Frank von Hippel	Copenhagen
20-02-1978	Amory Lovins	Copenhagen
29-03-1979	Klaus Traube	Copenhagen
08-04-1979	Robert Jungk	Copenhagen
03-05-1979	Amory Lovins	Copenhagen
21-08-1979	Alice Stewart	Copenhagen
30-10-1979	Karl Morgan, George Kneale, Alice Stewart, Rosaly Bertell, at: "Kraeftrisiko ved lave strålingsdosis" (Risk of cancer due to low-level radiation)	Copenhagen
26-11-1979	Kitty Tucker	Copenhagen
03-03-1980	Donald Geesaman	Copenhagen
08-03-1980	Robert Pollard, Daniel Ford and Steven Nadis	Copenhagen
19-03-1980	Carl Johnson	Copenhagen
09-05-1984	Frede Hvelplund, Klaus Illum, Johannes Jensen, Niels I Meyer, Joergen S. Nørgaard, Bent Sørensen	Copenhagen
26-02-1991	Alexander Salmygin	Copenhagen

Event Analysis 3:
Mobilisation of counter-expertise through events with foreign experts and the mobilisation of pro-nuclear expertise by Risø employees and REO members to challenge and attack the anti-nuclear movement

This event took place between 1973 until 1991, with public events mostly held in Copenhagen, at times also elsewhere; the controversy also took place in national media.

Actors

The main actors participating in this controversy about nuclear energy involved can be divided into a pro-nuclear and anti-nuclear camp. The promoters of nuclear energy hailed from scientific bodies. Among them were employees of the Risø research centre, e.g. Heinz Hansen, who wrote opinion pieces in various publications (OOA 1974–1989). In the 1970s, the Risø research establishment was the well-connected hub of nuclear expertise and advocacy in Denmark. Among interest groups, the Reel Energi Oplysning (Real Energy Information) was founded in 1976, with Heinz Hansen being one of the founding members (Oplysning 2016). There were network ties and overlapping memberships between Risø, the Niels Bohr Institute/Institute for Theoretical Physics (via Bent Elbek, another founding member of REO) and REO (Oplysning 2016).

On the anti-nuclear side, the social movement organisation OOA played a central role by mobilising scientists as experts. OOA maintained manifold transnational connections with anti-nuclear groups in Europe. This involved efforts notably by Siegfried Christiansen on behalf of OOA to collaborate at the level of the European Communities, including Euratom, in Brussels and internationally to foster alternative energy sources (Meyer 2014, 229, e.g. OOA 1977, Atomkraft 1977, Christiansen 1978).

With a view to societal trust, contemporary actors did not emphase the distinction between public and private actors. Generally, many contemporary anti-nuclear activists were sceptical towards the intermingling of public and private interests, and more generally towards the profit-interest of private companies.

Public Engagement

Public engagement initiated and employed by the promoters predominantly involved public communication, mostly in the media. Critics of nuclear energy also initiated events, by inviting counter-experts for evening or weekend discussions. Such events routinely started out with public communication, with a talk by an invited expert. However, often the debates actually had an interactive format, conforming rather to the model of public participation.

Both promoters and opponents of nuclear energy initiated events. The OOA organised a series of public events with foreign experts. Debates in the letters to the editor sections of newspapers were started by either side, provoking a response from the other side. For instance, researchers from Risø authored newspaper articles discussing – and usually dismissing – the information, knowledge and views of nuclear critics. When opponents of nuclear power initiated events, they often sought to invite public authorities to respond, and criticised them for not being willing to engage.

Arguments and Behaviour

Interactions between the nuclear sector and civil society played out in a war of words among experts not in violence or use of force. The foreign counter-experts mobilised by OOA clearly highlighted the perceived risks and problematic implications of nuclear power. Conversely, supporters of nuclear power, like Heinz Hansen (OOA 1974–1989), often dismissed the credibility of these counter-experts.

Clearly, this debate involved a lot of passion and emotion. Highly motivated actors engaged on both sides. They believed in their cause with substantial zeal. While the prominence of the different arguments changed over time, the confrontational style did not give way to acceptance or tolerance.

Arguments of the promoters of nuclear power were often politically framed. Three features were most prominent:
- A critique of the scientific credibility of those counter-experts, attacking the quality of their science, and their lack of relevant expertise, in line with the attack on counter-expertise that has been described for instance for the French experience (Topçu 2008).
- A critique of their political position, e.g. by denigrating them as unreliable left-wingers, who only criticised Western corporate nuclear power, and ignored the dangerous plants in socialist countries (OOA 1974–1989).
- Finally, pro-nuclear actors argued that concerns about safety were exaggerated.

The arguments of the critics of nuclear power were equally political and varied with their respective approaches to the problem:
- "There is no such thing as safe enough": This argument highlights the dangers of low-level radiation that has been put forward by American researchers in the early 1970s, notably by Dean Abrahamson, Arthur Tamplin, and John Gofman (Gofman and Tamplin 1971, Semendeferi 2008).
- The "nuclear state" argument popularised by Robert Jungk (Jungk 1977), see discussion on event 2 above, that the safety requirements of nuclear power would lead to an all-powerful and dictatorial government.
- The critique of the centralised structure of energy provision, which contradicted both Danish traditions and popular democracy. This argument was popularised also by Armory Lovins, who was invited by OOA to speak and publish in Denmark (Lovins 1976, OOA 1973–1980, Lovins 1979)

The arguments under debate clearly link nuclear issues to societal problems, ideological cleavages, and societal visions of the future.

Event 4: Anti-nuclear protest organised by the OOA (1970s/1980s), notably against the Barsebäck power plant in Sweden near Copenhagen

In 1975 and 1977, at the time of the most vibrant debate about nuclear energy and energy policy in Denmark, two nuclear reactors went on line in the vicinity of the Danish capital. The two reactors of the power plant at Barsebäck, Sweden, were located only 20 km from central Copenhagen, as the opponents routinely highlighted. Its two towering blocks were visible from the beaches and port sides in Northeastern Sealand, making the potential threat to Danish citizens symbolically visible. The power plant was originally intended to have up to six reactors. It was operated by the Swedish company Sydkraft, and delivered nuclear-generated electricity also to consumers in Denmark, through a thick cable on the ground of the narrow Sound (Öresund) that separates the Danish archipelago from the Scandinavian Peninsula.[6]

As the Danish decision to move towards developing nuclear power within Denmark had been put on hold in 1976, the Danish anti-nuclear organisation OOA and other anti-nuclear groups in Denmark made Barsebäck one of the key targets of its campaigns. In 1976, environmental groups from Norway, Sweden and Denmark marched against Barsebäck, and OOA organised a march with torchlights in Copenhagen in December 1976 (Nielsen 1976). Since then OOA as well as local anti-nuclear groups organised marches from all parts of Denmark to Barsebäck, for demonstrations together with the Swedish anti-nuclear movement almost every year (OOA 1980, 1979b, 1978, Nielsen 1976). The intensity of the OOA's involvement, and the types of activities targeting Barsebäck, however, varied (Christiansen 2019a, b). The protesters specifically highlighted the risk of nuclear accidents, so close to Copenhagen (Storm 2014, 55, 59, Petersen 1996, 174–176), while the REO produced a leaflet in 1982 that dismissed these concerns (Korsbech 1982).

The Danish anti-nuclear movement's battle against the power plant in neighbouring Sweden continued for more than twenty years (Löfstedt 1996). It involved diplomatic pressure from the Danish government, a Danish-Swedish joint parliamentary commission of enquiry in 1983–84 (Barsebäckvaerket 1985), a motion of the Danish parliament in 1986 (Folketinget 1986) and direct communication of the OOA with Swedish Social Democrats, until the power plants were finally closed down in 1999 and 2005, after the privatisation of Sydkraft (Storm 2014, 67, Kaijser and Meyer 2018c).

6 A more comprehensive account of the Danish-Swedish conflicts and cooperation around Barsebäck can be found in an article jointly written with the author of the chapter on Sweden in this volume, Arne Kaijser (Kaijser and Meyer 2018c). On the issue of nuclear installations at the border in other European border areas see the contributions to the special issue, which was edited by the two authors. (Kaijser and Meyer 2018a, b, Rubio-Varas, Carvalho, and Torre 2018, Kirchhof 2018, Renard 2018).

Eventually, the decision to close down Barsebäck can be linked to the engagement of the Danish (and Swedish) population with nuclear power, and their ongoing protest. Indeed, the annual marches, collections of signatures and demonstrations can be considered one long-term event in the transnational history of Scandinavian societies and nuclear power (Buns 2017). Hence, more than the other events, the protest against Barsebäck was recognised by the contemporaries as important and covered by the media. It became a point of reference in subsequent debates. The transnational slogan called "Hvad ska' væk – Barsebäck. Hvad ska' ind – sol og vind" ("What needs to go – Barsebäck, what do we need instead – sun and wind"), which sounds similar in Danish and Swedish, equally linked Barsebäck to the need for a transition to small-scale and renewable energy sources. This demonstrates the symbolic importance of Barsebäck in the Danish and Scandinavian conflicts about nuclear energy.

Event analysis 4: Anti-nuclear protest organised by the OOA (1970s/1980s), notably against the Barsebäck power plant in Sweden

From 1976 until 1986 almost every year – with the exception of 1979 and 1981 – protest marches led from different places in Denmark and Sweden to Barsebäck. The participation of the different groups however varied over the years and different types of protest were tried, including the collection of signatures, protest in front of the Swedish embassy etc. (Christiansen 2019a, b).

Actors

The main promoter of the nuclear power plant in Barsebäck was a Swedish state-owned company. The Swedish utility Sydkraft, later privatised to become part of the German company Eon Energy, was the object of the protest, as it was operating Barsebäck. Protest also targeted political parties and the government in Denmark, to raise awareness and in order to convince them to protest against Barsebäck with the Swedish authorities (Haaland 1978, OOA 1979a). Protest also addressed Swedish government authorities and political parties, such as the Swedish socialists, directly (OOA 1975–2000).

Actors from civil society, namely the anti-nuclear social movement organisation OOA, was among the organisers of the protest marches and other protest events, mobilising thousands of citizens and lobbying the Danish and Swedish governments. Danish authorities eventually responded to such pressures by communicating with the Swedish side, setting up common government commissions (Barsebäckvaerket 1985). Danish authorities also issued emergency information to citizens (see below figure 4) (Miljøstyrelsen 1986).

While trustful cooperation between Danish and Swedish authorities already existed at the time, when Barsebäck was planned (Nilsson 2002), the OOA built up alliances with Swedish anti-nuclear activists (Kaijser and Meyer 2018c). The Swedish authorities were the regulators for the Barsebäck plant. Repeated Danish reports on the oversights of Swedish regulators pointed to a decrease in the level of transnational trust.

Public Engagement

The public engagement was initiated by the opponents, the Danish (OOA) and the Swedish anti-nuclear movements and involved protest marches and demonstrations which amount to public participation. Protest addressed the Danish government, for instance, when in the wake of the Three Mile Island accident, the OOA collected some 312,000 signatures calling upon Danish premier Anker Jørgensen to demand the closure of Barsebäck from the Swedish government (Kaijser and Meyer 2018c).

By contrast, the promoter, the Swedish utility Sydkraft, invited e.g. a Danish girl's orchestra to play at the topping out party of the second reactor in Barsebäck. This event could be characterised as a public communication event. Communicating the power station to the local residents, including assurances about its safety, was targeted at the Swedish communities around the plant (Storm 2014, 53–55).

Protest events were initiated by OOA and its partners, i.e. the opponents, and involved marches and demonstrations. OOA also engaged in different lobbying activities. The interaction between the promoters of the plant and the "affected people" differed. While Sydkraft/Eon energy did not effectively reach out across the border, they enjoyed substantial support locally and among their employees, who protested against the imminent closure of the plant by symbolically encircling it (Storm 2014, 64–67).

Meanwhile, the OOA evaluated their own marches, assessing problems, e.g. in the cooperation with the Swedish side, in order to improve its campaigns (OOA 1978).

Arguments and Behaviour

The transnational social conflict about nuclear power found expression in protest event and marches. Protest of Danish citizens – mobilised and organised by OOA and Swedish citizens – however remained non-violent. People marched and sang protest songs and stood their ground in front of the power plant to demonstrate their disapproval.

There was very little evidence of acceptance on the Danish side, in particular, once it became clear that Denmark would not introduce commercial nuclear power plants. The goal of the OOA was to close down Barsebäck, as it was considered a potential threat to the Danish capital region, in case of a nuclear accident. This was even more clearly highlighted after Three Mile Island and Chernobyl, and illustrated with various images demonstrating that Copenhagen was going to be in the most heavily devastated zone after an accident (Sørensen 1982). Barsebäck was routinely described as the world's worst location for a power plant, due to its proximity to the large Copenhagen conurbation (Nielsen 2000). In the face of this debate, a growing number of Danes dismissed the promoter narrative about cheap and reliable energy provision (also for Danish consumers), and the irrelevance of safety concerns, which promoters routinely dismissed as exaggerated (Korsbech 1982).

The Danish government did not actively side with the Swedish utility across the Sound. Under pressure from the OOA, the Danish government called for greater information on the safety. Together with the Swedish, they set up an experts' committee in 1983/84 to study the safety of the plant (Barsebäckkommittén 1985, see Kaijser and Meyer 2018c for further detail). However, already in the 1970s, the Danish environmental agency examined the potential consequences of an accident at Barsebäck for Denmark and developed recommendations (Henningsen 2017).

Event 5: Responses to Chernobyl and transnational activities in the context of the "Radiating Neighbours" campaign of 1986

In the wake of the debate on nuclear power since the 1970s, Chernobyl in April 1986 was viewed by many contemporaries as clear evidence that nuclear power involved actual and considerable risks. As a response to this, the OOA reinforced its routine requests to public authorities about safety procedures (OOA 1974–2000) on risks nearer to home, notably the Barsebäck plant. After Chernobyl, the Danish environmental agency issued safety information to Danish households, indicating what to do in case of emergency (OOA 1974–2000).

The OOA also embarked on its own attempts at what social scientists described as "NGO diplomacy" (Betsill and Corell 2007). After Chernobyl, it kicked off the "Radiating Neighbours" campaign targeting all nuclear power plants within 150 km of the Danish borders; in Sweden, West and East Germany. Over the summer of 1986, the OOA collected some 160,000 signatures, which they handed over to the West and East German and Swedish ambassadors in September 1986, in a large demonstration to the embassies (Meyer 2016, Kaijser and Meyer 2018c). In the wake of this, the OOA received an invitation to visit the German Democratic Republic in October 1986, to voice their concerns about East German power plant projects, on the Southern coast of the Baltic Sea, in the vicinity of Southern Denmark (Christiansen 1986a). Danes were particularly worried because the East Germans relied on seemingly highly problematic Soviet nuclear technology (OOA 1983–ca.1990). At the same time, the OOA self-assuredly offered to advise the GDR on renewables policy (Christiansen 1986b). They also visited East German anti-nuclear activists at the East Berlin Umweltbibliothek (Heitmann 1986).

While Chernobyl as an event clearly had an impact on nuclear policy in East and West, the activities covered at this event only made a small difference. The signature collection and the visits to Stockholm, East Berlin and Bonn were not recognised as important, even though they were transnationally mentioned in newspapers (in East Germany, West Germany and Denmark, as for the visit to East Berlin). Unlike Chernobyl itself, the "Radiating Neighbours" campaign did not subsequently become a point of reference.

Event Analysis 5: Responses by the OOA to Chernobyl: The "Radiating Neighbours" campaign of 1986

This event took place in throughout Denmark while collecting signatures, in Copenhagen, for the protest in front of the embassies, and across the Iron Curtain, with a visit to East Berlin. The campaign also involved visits of OOA delegations to Stockholm and subsequently also to Bonn. The visits to Stockholm and Bonn are not analysed in detail in this section.

Actors

The main promoter of nuclear energy involved was the East German government and its representatives, including junior ministers, whom the OOA delegation visited. The OOA considered itself the representative of the citizens potentially

Figure 4 "Being ready for Barsebäck", information leaflet. 1 million copies distributed by the Danish Environmental Administration (Miljøstyrelsen) to all households in the Copenhagen conurbation in August 1986 in the wake of Chernobyl

Figure 5 Chernobyl highlighted the transboundary effects of radiation, and led the Danish anti-nuclear organisation OOA to collect 160,000 signatures against nuclear power plants in Sweden, East and West Germany in 1986. They were handed over to the Copenhagen embassies of the three countries. Campaign poster "Join OOA's signature collection drive: Radiating Neighbours – Thanks anyway", 1986

affected by an accident at any nuclear power plant within 150 kms of the Danish national borders, thus this social movement organisation engaged in this type of protest and in NGO diplomacy.

The campaign "Strålende naboer" – "Radiating Neighbours" was very sophisticated. It combined the collection of signatures with a protest march and the submission of these signatures to the embassies of the GDR, the FRG and Sweden, and included lobbying and direct contacts with decision-makers. With its signature collection, OOA repeated a similar campaign after Three Mile Island, which however was directed at the Danish national government, rather than directly at the foreign governments (Kaijser and Meyer 2018c).

Transnational networks and alliances with West German anti-nuclear activists played an important part in finding civil society activists in GDR to visit, next to the official visit of the GDR state authorities (Christiansen 1986b). Upon their visit to East Berlin, the Danish OOA activists sought to talk to the East German regulators, potentially also in order to enquire about their trustworthiness.

Public Engagement

Public engagement in the context of the OOA's "Radiating Neighbours" campaign in Denmark included public communication, i.e. the distribution of information to citizens, the collection of some 160,000 signatures, protest in front of the embassies, and an invitation to talk with high-level embassy staff. In East Berlin, it involved participation along the lines of diplomacy, in which the OOA was given polite, but often not very far reaching concessions, e.g. that an article on renewable energy sources was to be published in an East German newspaper.

The events were initiated by the critics of nuclear power, by their protest (including a night guard protest in front of the Soviet embassy in Copenhagen one year after Chernobyl). An OOA delegation visited East Berlin to talk to authorities and civil society groups (closely surveyed by the GDR secret service) (Heitmann 1986).

The interaction between promoters and critics of nuclear power was characterised by a blend of lobbying, diplomacy and asking critical questions on behalf of the OOA, and by public information by the authorities.

Arguments and Behaviour

In the aftermath of Chernobyl, there was conflict and protest, however, no violence. Protest was peaceful and symbolic. On the part of the OOA, it involved peaceful behaviour such as the collection of signatures and public demonstrations in front of foreign embassies.

Those Danes active in protest and those offering their signatures clearly did not respond to Chernobyl with tacit acceptance. The main critique related to the safety issue, and Chernobyl seemed to provide clear evidence of the risks nuclear power involved even at great distances. Fear of accidents was the overwhelmingly important argument (OOA 1983–ca.1990).

The Danish government's response was to engage in diplomatic exchange with neighbours who maintained nuclear power plants, and to encourage them to improve safety or close down.

The GDR Government sought to win a diplomatic victory in the context of Cold War competition with West Germany by demonstrating their openness to Danish protest, and willingness to talk about the issue. However, they insisted that they had to produce electricity and that nuclear energy was the best way – in the face of the GDR's heavy reliance on burning highly polluting lignite. Nevertheless, after Chernobyl the GDR accepted that they would have to improve the safety of nuclear plants, and thus delay construction. In the GDR, the vision of high energy-consumption and industrial progress was part of the official view of industrial socialist modernity, with any opposition to it strictly monitored and frequently suppressed.

Facts & Figures[7]

The purpose of this section is to give an overview of nuclear power in Denmark. It contains such data as the number of reactors, reactors' locations, technical and chronological details of reactors' construction as well as statistics on electricity production, periodization, and social connections to nuclear constructions.

Key facts on nuclear technology

- Danish researchers contributed importantly to nuclear research, notably Nobel Prize laureate nuclear physicist Niels Bohr (1885–1962).
- The backbone of Danish nuclear research in the postwar period were three research reactors at the Risø research establishment on Roskilde fjord which are now decommissioned.
- Denmark has no nuclear power plants. Imported nuclear power is supplied to its grid, mostly from Sweden, and to lesser extent from Germany, as well as water power from Norway.
- Low level nuclear waste from three research reactors remained in Denmark after the closure of the research reactors of the Risø research centre. Spent fuel has been sent back to the US. The government has been searching for a place for a repository within the country, and started engaging with stakeholders (Denmark 2017).
- Greenland is a prospective place to mine uranium. Recently the Danish government issued legislation that created a legal framework to export Greenland's uranium. Uranium will be supplied under bilateral nuclear cooperation under Euratom and IAEA (Arnfred 2016, Walsh 2017).
- Denmark offers incentives to encourage the use of renewable energy. Danish researchers and entrepreneurs have been among of the pioneers of wind power since the 1970s.

7 Assembled by Aisulu Harjula, Lappeenranta University of Technology

Key dates and abbreviations

Key dates

1921	The Institute for Theoretical Physics was founded by Niels Bohr (1885–1962) in Copenhagen.
1922	Niels Bohr received the Nobel Prize in physics "for his services in the investigation of the structure of atoms and of the radiation emanating from them."
1939	Nuclear fission was proved for the first time experimentally.
1957–1960	The Danish Atomic Energy Commission commissioned three research reactors.
1965	The Institute for Theoretical Physics was renamed to Niels Bohr Institute.
1975	The second research reactor DR-2 was shut down because of the decision to substitute it with the bigger research reactor DR-3.
1985	The Danish parliament decided that nuclear power plants will not be built in the country.
1999	The Danish parliament decided to reform energy policy with a view to electricity provision that enables competition and promotes renewable sources.
1999	The third research reactor DR-3 had a leak in drain pipe. Decision was made not to put it back to operation. Used fuel was shipped to USA.
2000	The third research reactor was shut down.
2001	The second research reactor was shut down.
2001	Production of uranium fuel for research reactors was stopped.
2007	Government established a plan to provide 30% of energy consumption coming from renewables by 2020 and 50% of electricity consumption from wind energy.
2007–2016	Preparations and legislation about uranium mining in Greenland
2016	A legal framework to export uranium from Greenland was created. Greenland is independent to mine uranium but its export required Danish authorisation (Arnfred 2016).

Abbreviations

IAEA	International Atomic Energy Agency
WMP	Waste management Plant
MW	Megawatt

List of reactors and technical and chronological details

The tables below show the list of research reactors, operators as well as the dates of their operation.

Table 1 – Research nuclear reactors in Denmark

Name	Use	Operator	Type & MWt	Operation start	Shutdown	Decommissioning
DR-1	research, education	Risø National Laboratory	low power 0,002 MW	1957	2001	2006
DR-2	physics research, production radioacktive isotopes	Risø National Laboratory	5 MW	1959	1975	2005–2008
DR-3	neutron physics research, materials tests, production of radioactive isotoptes for medicine and industry	Risø National Laboratory	10 MW heavy water	1960	2000	by 2020

Table 2 – Decomissioned nuclear facilities in Denmark

Facility	Operation start	Shutdown	Decommissioning
Fuel fabrication facility		2001	2015
WMP	1964	1989	2008–2012

References

Interviews

Christiansen, Siegfried. 2017. *Interview with Siegfried Christiansen, founding member of OOA, conducted by Jan-Henrik Meyer, 28 September 2017.* Copenhagen.

Henningsen, Jørgen. 2017. Interview with Jørgen Henningsen, former official in Danish environmental ministry and director in the European Commission, conducted by Jan-Henrik Meyer, 29 September 2017. Copenhagen, soon available from "Oral History", The European Commission 1986–2000, https://www.eui.eu/Research/HistoricalArchivesOfEU

Nielsen, Jørgen Steen. 2016. *Interview with Jørgen Steen Nielsen, founding member of OOA, conducted by Jan-Henrik Meyer, 11 May 2016.* Copenhagen.

Weish, Peter. 2013. *Interview with Peter Weish, conducted by Jan-Henrik Meyer, 22 August 2013.* Munich.

Archives

Historical Archive of the European Commission, Brussels:

OOA. 1977. "Press release by the Organisationen til Oplysning om Atomkraft, 1 December 1977." *Historical Archives of the European Commission* BAC 144/1987, Presse Nuklear-Hearings, 29.11.–1.12.1977, 24.–26.1.1978 (255): 266.

Green Memory Archive (AGG), Berlin,:
Petra Kelly Archive (PKA):

Atomkraft, Organisationen til Oplysning om. 1977. "Transnationaler Energie-Informationsdienst mit Geld von der lachenden Sonne. An alle Bürgerinitiativen gegen Atomkraftwerke, Copenhagen, 14 Dezember 1977." AGG PKA (3176).

Christiansen, Siegfried. 1978. "Organisationen til Oplysning om Atomkraft, to the participants in The Salzburg Conference for a non-nuclear future, 29 April–1 May 1977 and the World Congress against Nuclear Power, Gothenburg, 13–16 May 1976, Copenhagen, 11 January 1978." AGG PKA (3176).

Rigsarkivet, Copenhagen:

Christiansen, Siegfried. 1986a. "Letter to GDR ambassador Norbert Jaeschke, 20 September 1986, Materiale vedr. internationalt arbejde: Sovjet/Rusland Henvendelser 1983 – Henvendelser 1986." *Rigsarkivet*, OOA 10451 (134).

——. 1986b. "Notes for visit to Berlin, 12 September 1986, Materiale vedr. internationalt arbejde: Sovjet/Rusland Henvendelser 1983, Henvendelser 1986." *Rigsarkivet*, OOA 10451 (134).

Forsoningsforbundet, International Fellowship for Reconciliation, and Siegfried Christiansen. 1973. "Kortfattet (meget kortfattet) rapport for seminar i Lyngby i dagene 15.6.–17.6.1973, 10.8.1973." Folder: Energiprojekt OOA, Planlægningsmøder, 5.6.73–31.1.1974, in: Mødereferater med bilag fra tirsdagsmøder 1974–1995." *Rigsarkivet*, OOA 10451 (40):1–3.

Geertsen, Uffe. 1974–1976. "Sekretariatsleder for Handelsministeriets energioplysningsudvalg: Debatten i medierne." *Landsarkivet for Nørrejylland.*

Heitmann, Renate. 1986. "Bericht über den Besuch einer dänischen Delegation von Kernkraftgegnern in Ost- und West-Berlin, 16 October 1986. Materiale vedr. internationalt arbejde: Sovjet/Rusland Hevendelser 1983 – Henvendelser 1986." *Rigsarkivet*, OOA 10451 (134).

Miljøstyrelsen. 1986. "Om Barsebäck-beredskabet – til samtlige husstande i Hovedstadregionen." In: Større aktiviteter, kampagner og aktioner: Magasinenhed: Herning Folkeafstemningsseminar 1978, Århus Seminar om efterårsseminar 1982 m.m. 1974–2000." *Rigsarkivet*, OOA 10451 (82).

OOA. 1973–1980. "OOA Materiale vedr. Offentlige møder og høringer 1973–1980." *Rigsarkivet,* OOA 10451 (73).

——. 1974. "Pressemeddelse, 31.1.1974." Folder: Energiprojekt OOA, Planlægningsmøder, 5.6.1973–31.1.1974. In: Mødereferater med bilag fra tirsdagsmøder 1974–1995. *Rigsarkivet,* OOA 10451 (40).

——. 1974–1989. "Articles by Heinz Hansen, Risø. In: OOA Materiale vedr. tilhængere af atomkraft." *Rigsarkivet,* OOA 10451 (114).

——. 1974–1995. "Energiprojekt OOA, Planlægningsmøder, 5.6.1973–31.1.1974. In: Mødereferater med bilag fra tirsdagsmøder." *Rigsarkivet,* OOA 10451 (40).

——. 1974–2000. "Større aktiviteter, kampagner og aktioner: Magasinenhed: Herning Folkeafstemningsseminar 1978, Århus Seminar om efterårsseminar 1982 m.m." *Rigsarkivet,* OOA 10451 (82).

——. 1975–2000. "Materiale vedr. Barsebäck aktiviteter – Socialdemokraternes kongres i Sverige 1987." *Rigsarkivet,* OOA 10451 (117).

——. 1976. "Atomkraft – med fremtid som indsats." Poster for evening debate with the Swedish nuclear physicist and Nobel Prize winner Hannes Alfvén, 22 April 1976. In: OOA Materiale vedr. Offentlige møder og høringer 1973–1980." *Rigsarkivet,* OOA 10451 (73).

——. 1978. "Materiale vedr. Barsebäck-aktiviteter: Efterkritik og erfaringer 1978 m.m." *Rigsarkivet,* OOA 10451 (12).

——. 1979b. "Materiale vedr. Barsebäck-aktiviteter: Barsebak-demonstrationen 1979." *Rigsarkivet,* OOA 10451 (13).

——. 1980. "Materiale vedr. Barsebäck-aktiviteter: Barsebak march 1980 m.m." *Rigsarkivet,* OOA 10451 (125).

——. 1983–ca. 1990. "Materiale vedr. internationalt arbejde: Sovjet/Rusland Henvendelser 1983 – Henvendelser 1986." *Rigsarkivet,* OOA 10451 (134).

Unpublished sources

Christiansen, Siegfried. 2019a. *OOA Chronologie, based on OOA documents.* Copenhagen: OOA private archive, Siegfried Christiansen.

——. 2019b. Personal E-mail Communication to Jan-Henrik Meyer, 5 February 2019. Copenhagen.

Published sources and literature

Arnfred, Carl Emil. 2016. "Tidligere sagde vi nej tak til atomkraft – nu skal Danmark sælge uran. Folketinget har banet vejen for, at Danmark i de kommende år kan sælge uran fra Grønland. Kritikere frygter, at det radioaktive materiale havner i udenlandske våbenprogrammer." Politiken, last modified 2 June 2016, accessed 18 March 2019. https://politiken.dk/magasinet/feature/art5624385/Tidligere-sagde-vi-nej-tak-til-atomkraft-nu-skal-Danmark-sælge-uran.

Barsebäckkommittén. 1985. "Rapport från den dansk-svenska kommittén 1983–84 om Barsebäckverket." *Departmentskrift Industridepartementet (DsI), Stockholm* (1).

Barsebäckvaerket, Dansk-Svensk Komité 1983–84 om. 1985. In: *Rapport fra den dansk-svenske komité 1983-84 om Barsebäckvaerket.* Copenhagen: Miljøministeriet.

Betsill, Michele M., and Elisabeth Corell, eds. 2007. *NGO Diplomacy: The Influence of Nongovernmental Organizations in International Environmental Negotiations.* Boston: MIT Press.

Bondesen, Erling, Ellen Buch-Hansen, Uffe Geertsen, and Bue Nielsen, eds. 1975. In: *Energiressourcer, økonomi og politik (Grundbog no. 5).* Copenhagen: Energioplysningsudvalget.

Buns, Melina Antonia. 2017. "Marching Activists: Transnational Lessons for Danish Anti-Nuclear Protest" *Environment and Society Portal: Arcadia* (18). doi: https://doi.org/10.5282/rcc/7918.

Christensen, Nikoline Ridder. 2002. "Atoms for Peace & Pax Americana. Den amerikanske indflydelse på danske beslutninger angående atomenergi og atomkraft " *Den jyske historiker* 97 (Den genstridige bonde: råderum i dansk udenrigspolitik i den kolde krigs epoke): 87–106, 187.

Christiansen, Siegfried. 1975. "Atomkraft - en energipolitisk blindgyde." In: *Atomkraft? (Grundbog no. 2)*, edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan: 126-130. Copenhagen: Energioplysningsudvalget.

Christiansen, Siegfried. 1977. "'Den danske oplysningskampagne om atomkraft 1974-1977', juni 1977. Text prepared for "International Seminar on Training for Nonviolent Action" 6.-27. juli 1977, Guernavaca, Mexico.". Danmarkshistorien.dk, Last Modified 2018, accessed 7 November 2019. http://danmarkshistorien.dk/leksikon-og-kilder/vis/materiale/sigfred-christiansen-den-danske-oplysningskampagne-om-atomkraft-1974-1977-juni-1977/.

Danielsen, Oluf, Uffe Geertsen, Frede Hvelplund, Vagn Korsgaard, Niels I. Meyer, Bent Sørensen, and Energioplysningsudvalget. 1975. In: *Alternative energikilder og -politik (Grundbog no. 6).* Copenhagen: Energioplysningsudvalget.

Degnbol, Poul, Uffe Geertsen, Jan Krag Jacobsen, Bent Jørgensen, Anders Serup Rasmussen, and Henning Schroll, eds. 1975. In: *Energibrug og miljøproblemer (Grundbog no. 4).* Copenhagen: Energioplysningsudvalget.

Denmark, Ministry of Higher Education and Science. 2017. "Disposal of radioactive waste." Last modified 19 April 2017, accessed 18 March 2019. https://ufm.dk/en/newsroom/issues/radio-active-waste.

Ecologist/FoE. 1972. "Swedish Cover-Up on Nuclear Safety." *Stockholm Conference Eco, edited by the Ecologist and Friends of the Earth, 7 June 1972*, 1, 8.

Edwards, Bob, and John D. McCarthy. 2007. "Resources and Social Movement Mobilization." In: *Blackwell Companion to Social Movements*, edited by David A. Snow, Sarah A. Soule and Hanspeter Kriesi, 116–152. Oxford: Oxford University Press.

Elbæk, Bent. 1975. "Energi og samfundsudvikling." In: *Energipolitik (Grundbog no. 1)*, edited by Uffe Geertsen, 16–47. Copenhagen: Energioplysningsudvalget.

Energioplysningsudvalget. 1975a. *Alternative energikilder og -politik (Grundbog no. 6).* Copenhagen: Energioplysningsudvalget.

———. 1975b. "Energioplysningsudvalget." In: *Alternative energikilder og-politik (Grundbog no. 6)*, edited by Oluf Danielsen, Uffe Geertsen, Frede Hvelplund, Vagn Korsgaard, Niels I. Meyer, Bent Sørensen and Energioplysningsudvalget, 186–189. Copenhagen: Energioplysningsudvalget.

Folketinget. 1986. "Forslag til folketingsbeslutning om lukning af atomkraftværket Barsebäck. Beslutningsforslag nr. B 139 Folketinget 1985–86 Blad no. 778. Fremsat den 22. april 1986 af Hans Hækkerup (S), Ritt Bjerregaard (S), Camre (S), Erik Holst (S), Tove Lindbo Larsen (S), Henning Nielsen (S) og Løvig Simonsen (S)." accessed 9 July 2019. http://www.ooa.dk/bb/folketbb.htm.

Foss, Niels. 1975. "Et Industri-synspunkt." In: *Atomkraft? (Grundbog no. 2)*, edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 148–149. Copenhagen: Energioplysningsudvalget.

Fritzbøger, Bo. 2014. "A Short Introduction to Danish Environmental History." University of Copenhagen, accessed 9 July 2019. http://static-curis.ku.dk/portal/files/117976311/A_Short_Introduction_to_Danish_Environmental_History_final.pdf.

Geertsen, Uffe, ed. 1975a. *Energipolitik (Grundbog no. 1).* Copenhagen: Energioplysningsudvalget.

——. 1975b. "Energipolitik og folkeoplysning." In: *Alternative energikilder og -politik (Grundbog no. 6)*, edited by Oluf Danielsen, Uffe Geertsen, Frede Hvelplund, Vagn Korsgaard, Niels I. Meyer, Bent Sørensen and Energioplysningsudvalget, 176–180. Copenhagen: Energioplysningsudvalget.

——, Gregers Algreen-Ussing, Carl Herforth, Hans Friis Mathiasen, Bent Sørensen, Michael Varming, and Jens Rosenkjær, eds. 1975. *Energiøkonomi og planlægning (Grundbog no. 3)*. Copenhagen: Energioplysningsudvalget.

——, Leif Henriksen, Lars Josephsen, and Ove Nathan, eds. 1975. *Atomkraft? (Grundbog no. 2)*. Copenhagen: Energioplysningsudvalget.

Gofman, John, and Arthur Tamplin. 1971. *Poisoned Power. The Case against Nuclear Power Plants*. Emmaus: Rodale Press.

Haaland, Tarjei. 1978. *Status i Barsebäck-debatten, redegørelse fra OOA som kommentar til Miljøstyrelsens redegørelse af oktober 1978*, edited by Tarjei Haaland. Revised edition. Copenhagen: Organisationen til Oplysning om Atomkraft.

Haber, Heinz. 1956. *Our Friend the Atom*. New York: Simon & Schuster.

Hein Rasmussen, Søren. 1997. *Sære alliancer, politiske bevægelser i efterkrigstidens Danmark*. Odense: Odense Universitetsforlag.

Henriksen, Leif. 1975. "Hvorfor sådan." In: *Atomkraft? (Grundbog no. 2)*, edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 7–9. Copenhagen: Energioplysningsudvalget.

Heymann, Matthias. 1998. "Signs of Hubris: The Shaping of Wind Technology Styles in Germany, Denmark, and the United States, 1940–1990." *Technology and Culture* 39 (4):641–670.

Jacobsen, E.L. 1975. "Elsams grundlaeggende opfattelse ved." In: *Atomkraft? (Grundbog no. 2)*, edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 131–135. Copenhagen: Energioplysningsudvalget.

Jamison, Andrew, Ron Eyerman, Jacqueline Cramer, and Jeppe Laessoe. 1990. *The Making of the New Environmental Consciousness. A Comparative Study of the Environmental Movements in Sweden, Denmark, and the Netherlands*. Edinburgh: Edinburgh University Press.

Jenkins, J. Craig. 1983. "Resource Mobilization Theory and the Study of Social Movements." *Annual Review of Sociology* 9:527–553. doi: https://10.2307/2946077.

Jungk, Robert. 1977. *Der Atomstaat. Vom Fortschritt in die Unmenschlichkeit*. Munich: Kindler.

——. 1984 [1977]. *The Nuclear State*. Parchment, MI: Riverrun Press.

Kaijser, Arne, and Jan-Henrik Meyer. 2018a. "Nuclear Installations at the Border. Transnational connections and international implications. An Introduction." *Journal for the History of Environment and Society* 3:1–32. doi: https://doi.org/10.1484/J.JHES.5.116793.

——. 2018b. "Siting Nuclear Installations at the Border. Special issue." *Journal for the History of Environment and Society* 3:1–178.

——. 2018c. "'The World´s Worst Located Nuclear Power Plant': Danish and Swedish perspectives on the Swedish nuclear power plant Barsebäck." *Journal for the History of Environment and Society* 3:71–105. doi: https://doi.org/10.1484/J.JHES.5.116795.

Kirchhof, Astrid Mignon. 2018. "East-West German Transborder Entanglements through the Nuclear Waste Sites in Gorleben and Morsleben." *Journal for the History of Environment and Society* 3:145–178. doi: https://doi.org/10.1484/J.JHES.5.116797.

Kitschelt, Herbert P. 1986. "Political Opportunity Structures and Political Protest. Anti-Nuclear Movements in four Democracies." *British Journal of Political Science* 16 (1):57–85.

Knudsen, Henrik, and Henry Nielsen. 2016. *Uranbjerget. Om forsøgene på at finde og udnytte Grønlands uran fra 1944 til i dag.* Copenhagen: Forlaget Vandkunsten.

Kolb, Felix. 2007. *Protest and Opportunities. The Political Outcomes of Social Movements.* Frankfurt: Campus.

Korsbech, Uffe. 1982. *Notat med nogle oplysninger om det, man kalder det værst tænkelige uheld på Barsebäck,* edited by Uffe Korsbech. Aarhus: Reel Energi Oplysning.

——, and P. L. Ølgaard. 1974. *Atomkraft i Danmark, fordele og ulemper.* Copenhagen: Lindhardt og Ringhof.

Kriesi, Hanspeter. 2007. "Political Context and Opportunity." In *Blackwell Companion to Social Movements,* edited by David A. Snow, Sarah A. Soule and Hanspeter Kriesi, 67–90. Oxford: Oxford University Press.

Krige, John. 2006. "Atoms for Peace. Scientific Internationalism and Scientific Intelligence." *Osiris* 21:161–181.

——. 2010. "Techno-Utopian Dreams, Techno-Political Realities. The Education of Desire for the Peaceful Atom." In: *Utopia/ Dystopia. Conditions of Historical Possibility* edited by Michael D. Gordin, Tilley Helen and Gyan Prakash, 151–175. Princeton: Princeton University Press.

Linderstrøm-Lang, C.U., and Niels I. Meyer. 1975. "Kendsgernerninger og vurderinger." In: *Atomkraft? (Grundbog no. 2),* edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 11–122. Copenhagen: Energioplysningsudvalget.

Löfstedt, Ragnar E. 1996. "Risk Communication. The Barsebäck nuclear plant case." *Energy Policy* 24 (8):689–696. doi: https://doi.org/10.1016/0301-4215(96)00042-0.

Lovins, Armory B. 1976. "Energy Strategy. The Road not Taken." *Foreign Affairs* 55 (1):65–96.

——. 1979. *Soft Energy Paths: Towards a Durable Peace.* New York: Harper & Row.

Lund, Anne, and Finn Breinholdt. 1979. "Dänemark – Atomkraft – Nein Danke. Wie man Atomkraft erfolgreich verhindern kann." In: *Der Atomkonflikt: Atomindustrie, Atompolitik und Anti-Atom-Bewegung im internationalen Vergleich,* edited by Mez Lutz, 83–100. Berlin: Olle & Wolter.

Mavhunga, Clapperton C., and Helmuth Trischler. 2014. "Energy (and) Colonialism, Energy (In)Dependence: Africa, Europe, Greenland, North America." *RCC Perspectives* 5 (5). doi: https://doi.org/10.5282/rcc/6554.

Meadows, Dennis, Donella Meadows, Erich Zahn, and Peter Milling. 1972. *The Limits to Growth.* New York: Universe Books.

Mejlgaard, Niels. 2009. "The trajectory of scientific citizenship in Denmark: Changing balances between public competence and public participation." *Science and Public Policy* 36 (6):483–496. doi: https://doi.org/10.3152/030234209x460962.

Melosi, Martin V. 2013. *Atomic Age America.* Houston: Pearson.

Meyer, Jan-Henrik. 2014. "'Where do we go from Wyhl?' Transnational Anti-Nuclear Protest targeting European and International Organisations in the 1970s." *Historical Social Research* 39 (1):212–235.

——. 2016. "Sun and Wind! The Critique of Nuclear Power & the Search for Alternatives in Denmark." Conference: Chernobyl – Turning Point or Catalyst? Changing Practices, Structures and Perceptions in Environmental Policy and Politics (1970s–1990s), 2–3 December 2016, Berlin.

——. 2018. "Hvad skal ind - sol og vind!" The Societal Debates on (Nuclear) Energy and the Origins of Danish Energy Transition in the 1970s. *How New Are the Renewables? Historicizing Energy Transitions.* Conference at Deutsches Museum, Munich, 21–23 February 2018, 1–16.

Mez, Lutz, and Birger Ollrogge. 1979/1981. "Dänemark." In: *Energiediskussion in Europa: Berichte und Dokumente über die Haltung der Regierungen und Parteien in der Europäischen Gemeinschaft zur Kernenergie*, edited by Lutz Mez and Birger Ollrogge, Sections 3.1–3.5. Villingen: Neckar-Verlag.

Møller, Steffen. 1975. "Et synspunkt fra fagbevaegelsen." In: *Atomkraft? (Grundbog no. 2)*, edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 150–151. Copenhagen: Energioplysningsudvalget.

Nielsen, Henry, and Henrik Knudsen. 2010. "The troublesome life of peaceful atoms in Denmark." *History and Technology* 26 (2):91–118. doi: https://doi.org/10.1080/07341511003750022.

——. 2013. "Too Hot to Handle: The Controversial Hunt for Uranium in Greenland in the Early Cold War." *Centaurus 55* (3):319–343. doi: https://doi.org/10.1111/1600-0498.12020.

——, Keld Nielsen, Flemming Petersen, and Hans Siggaard. 1999. "Risø and the Attempts to Introduce Nuclear Power into Denmark." *Centaurus 41* (1-2):64–92. doi: https://doi.org/10.1111/j.1600-0498.1999.tb00275.x.

Nielsen, Jørgen Steen. 1976. *Derfor må Barsebäck-vaerket stoppes, notat udarbejdet i forbindelse med den af OOA arrangerede demonstration i København den 3. december 1976 mod Barsebäckvaerket.* Edited by Tarjei Haaland. 2nd rev. ed. Copenhagen: Organisationen til Oplysning om Atomkraft.

——. 2000. "Barsebäck-sagens alt for stille diplomati." Information, accessed 19 February 2000. https://www.information.dk/2000/02/barseback-sagens-stille-diplomati.

Nilsson, T. 2002. "Redogörelse av kontakter mellan svenska och danska myndigheter när Barsebäcksverket uppfördes, 2002:12." SKI Rapport 2002 (12).

OOA. 1975. *Forslag til en dansk energipolitik, energiforsyning uden atomkraft, en artikelsamling om alternative energikilder og om mulighederne for at dække Danmarks forsyningsbehov uden atomkraft, OOA Saertryk no. 7.* Copenhagen: O.O.A.

——. 1979a. "De 3 hovedkrav. Luk Barsebäck. Open letter to Anker Jørgensen, 22 May 1979, signed by 311,950 people." *Atomkraft. Et kritisk tidsskrift om Atomkraft og Energipolitik* 6 (25/26, June): 5–7.

Oplysning, Ren Energi. 2016. "REOs Historie." Accessed 9 July 2019. http://reo.dk/?page_id=108.

Petersen, Flemming. 1996. *Atomalder uden kernekraft, forsøget på at indføre atomkraft i Danmark 1954-1985 set i et internationalt perspektiv.* Århus: Klim.

Petersen, Nikolaj. 2013. "The Politics of US Military Research in Greenland in the Early Cold War." *Centaurus* 55 (3):294–318. doi: 10.1111/1600-0498.12023.

Pfister, Christian. 2010. "The '1950s Syndrome' and the Transition from a Slow-Going to a Rapid Loss of Global Sustainability." In: *The Turning Points of Environmental History*, edited by Frank Uekötter, 90–118. Pittsburgh: University of Pittsburgh Press.

Renard, Claire Le. 2018. "The Superphénix fast breeder nuclear reactor – cross-border cooperation and controversies." *Journal for the History of Environment and Society* 3:107–144. doi: https://doi.org/10.1484/J.JHES.5.116796.

Risø. 1958. *Risø. The Research Establishment of the Danish Atomic Energy Commission. Information Leaflet.* Copenhagen: Risø Research Centre.

——. 1968. *Risø. The Danish Atomic Energy Commission Research Establishment Risø.* Copenhagen.

Rubio-Varas, Maria del Mar, António Carvalho, and Joseba de la Torre. 2018. "Siting (and mining) at the border: Spain-Portugal nuclear transboundary issues." *Journal for the History of Environment and Society* 3:33–69. doi: https://doi.org/10.1484/J.JHES.5.116794.

Rüdiger, Mogens. 2014. "The 1973 Oil Crisis and the Designing of a Danish Energy Policy." *Historical Social Research* 39 (4):94–112. doi: 10.12759/hsr.39.2014.4.94-112.

Semendeferi, Ioanna. 2008. "Legitimating a Nuclear Critic: John Gofman, Radiation Safety, and Cancer Risks." *Historical Studies in the Natural Sciences* 38 (2):259-301. doi: https://doi.org/10.1525hsns.2008.38.2.259.

Sidenius, Niels Christian. 1986. "Hvorfor er der ikke atomkraftværker i Danmark?" *Politica* 18 (4):377–401.

Sørensen, Bent. 1982. "Barsebæck og det værst officielt-tænkelige uheld." *IMFUFA Tekst, Roskilde Universitetscenter* 1982 (47):1–19.

Sørensen, Henning. 1975. "Grønlands uran." In: *Atomkraft? (Grundbog no. 2),* edited by Uffe Geertsen, Leif Henriksen, Lars Josephsen and Ove Nathan, 26–27. Copenhagen: Energioplysningsudvalget.

Sörlin, Sverker. 2013. "Reconfiguring Environmental Expertise." *Environmental Science and Policy* 28 (1):14–24.

Storm, Anna. 2014. *Post-Industrial Landscape Scars.* Basingstoke: Palgrave.

Tompkins, Andrew. 2016. *Better Active than Radioactive! Anti-nuclear Protests in 1970s France and West Germany.* Oxford: Oxford University Press.

Topçu, Sezin. 2008. "Confronting Nuclear Risks: Counter Expertise as Politics Within the French Nuclear Debate." *Nature and Culture* 3 (3):225–245.

Trischler, Helmuth, and Robert Bud. 2018. "Public technology: nuclear energy in Europe." History and Technology 34 (3–4): 187–212.

Van der Vleuten, Erik, and Rob Raven. 2006. "Lock-in and change: distributed generation in Denmark in a long-term perspective." *Energy Policy* 34:3739–3748.

Villaume, Poul. 2012. "Atomkraft – eller sol og vind." Gyldendal, last modified 02/03/2012, accessed 11 April 2019. http://denstoredanske.dk/index.php?sideId=306583.

Walsh, Maurice. 2017. "Mining. 'You can't live in a museum': the battle for Greenland's uranium." *The Guardian,* last modified 28 January 2017, accessed 18 March 2019. https://www.theguardian.com/environment/2017/jan/28/greenland-narsaq-uranium-mine-dividing-town.

Warde, Paul, Libby Robin, and Sverker Sörlin. 2018. *The Environment. The History of the Idea.* Baltimore: Johns Hopkins University Press.

Weart, Spencer R. 1988. *Nuclear Fear: A History of Images.* Cambridge, MA: Harvard University Press.

Wildi, Tobias. 2003. *Der Traum vom eigenen Reaktor. Die Schweizerische Atomtechnologieentwicklung 1945–1969.* Zürich: Chronos.

Astrid Mignon Kirchhof / Helmuth Trischler

The History behind West Germany's Nuclear Phase-Out

Executive Summary

Nuclear energy is intertwined with developments in social, economic, environmental, political, and cultural spheres. Therefore, it is a complex social and technological phenomenon that influences societies but is also shaped by societies as can be explored in this chapter about the history of the relations between nuclear energy and society in the Federal Republic of Germany (FRG, West Germany).

In the 1950s and the beginning of the 1960s, when the United States had launched the Atoms for Peace program and the first nuclear power plant went online in Germany, nuclear power seemed to be a modern solution to humankind's energy problems. Just over a year after the Federal Government had adopted the Atomic Energy Act in 1959 on the peaceful utilization of atomic energy and the protection against its hazards, the first nuclear power plant went online at the border of Hesse and Bavaria. With it, nuclear power in West Germany started as an industrial business. In the 1960s a phase of development and planning followed that was hardly noticed by the public. The first commercial nuclear reactor went on the grid in 1961, but it took many government incentives to convince energy companies to switch to nuclear power completely. The planning and building of nuclear power plants, radioactive waste disposal facilities, or reprocessing plants in the federal states of Baden-Württemberg (Wyhl), Schleswig-Holstein (Brokdorf), Lower Saxony (Gorleben), North Rhine-Westphalia (Kalkar), and Bavaria (Wackersdorf) provoked massive and recurring protests throughout the 1970s and 1980s. The protests against the construction of the plant in Wyhl (Kaiserstuhl) on the French border in Germany's southwest gave power to the nascent environmental movement when – in 1975 – 30,000 people demonstrated, occupying the site and developing protest structures.

Where nuclear sites were close to two or sometimes three different countries – for instance this was the case in protests against nuclear plants in Wyhl, people of diverse nationalities usually had similar interests. Furthermore, since the travel distances were rather minimal, it was easier to join and support local protests. Through activists, but also experts, politicians, organizations, and the media there was an exchange of knowledge and ideas. Women were often at the forefront

among critical citizens and since the 1970s they had raised their voices louder than ever. Especially the Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany and also gave rise to the Mothers against Chernobyl movement. As a result, a Ministry for the Environment was founded at the federal level and citizens' initiatives – many initiated and run by women – sprang up in high numbers. In 1998, the red-green coalition agreement decided to phase out nuclear energy within 20 years. Two years later, the Federal Government and electric supply companies signed an agreement about the future operation of German nuclear power plants. After a tsunami and partial meltdown at the Japanese nuclear power plant Fukushima Daiichi in 2011, the topic received renewed attention with continued protests. Chancellor Angela Merkel announced the shutdown of all German power plants by 2022 with eight of the 17 operating German reactors shut down immediately. Until March 2011, these 17 reactors produced 25 percent of the country's electricity. In 2016, the remaining eight reactors produced 16 percent, while half of Germany's electricity was generated from coal.[1]

1 This chapter is based on a short country report on the history of nuclear energy and its relation to society in the Federal Republic of Germany since 1945. It was part of a collection of 20 short country reports tackling the complex sociotechnical system around nuclear energy in different countries in the project 'History of Nuclear Energy and Society, HoNESt', funded by the Euratom Research and Training Programme Ref. 662268. The reports examine the history of nuclear energy in different countries, and document findings with references. Moreover they assemble information on basic elements of narrative and analysis for further historical research, and provide accessible information on nuclear-societal relations for the purposes of outreach and communication with stakeholders (civil society, industry, associations, policymakers, journalists).

Historical Context (Narrative)

Introduction to the historical context

Concerns about nuclear power were publicly expressed for the first time in the 1950s and 1960s and focused on the high costs, unproven technology, and dangers of nuclear waste disposals (Rudig 1990, 63). In later decades, activists criticized the Federal Government because they perceived the politics in which it pursued its big-industry projects as nontransparent and authoritarian (Glaser 2012, 12), and loyal state citizens often had experiences that turned their trust into skepticism. Large parts of the population frequently mistrusted both the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Moreover, low-level radiation, catastrophic disasters, disposal of radioactive waste, and other environmental impacts were criticized (Schils 2011, 4), alongside a more general critique of large-scale technology. Finally, opponents doubted that there were issues with alternative sources of energy and disapproved of the lack of the political will to actually invest in it (Hubert 2012). The societal controversy over nuclear energy that had already begun in the 1950s has been interpreted as a true success story of Germany's social and political culture (Radkau 1987; Weitze and Trischler 2006). The controversy was carried out at all societal levels and integrated not only small groups of experts and stakeholders, but numerous intermediary social groups and actors.

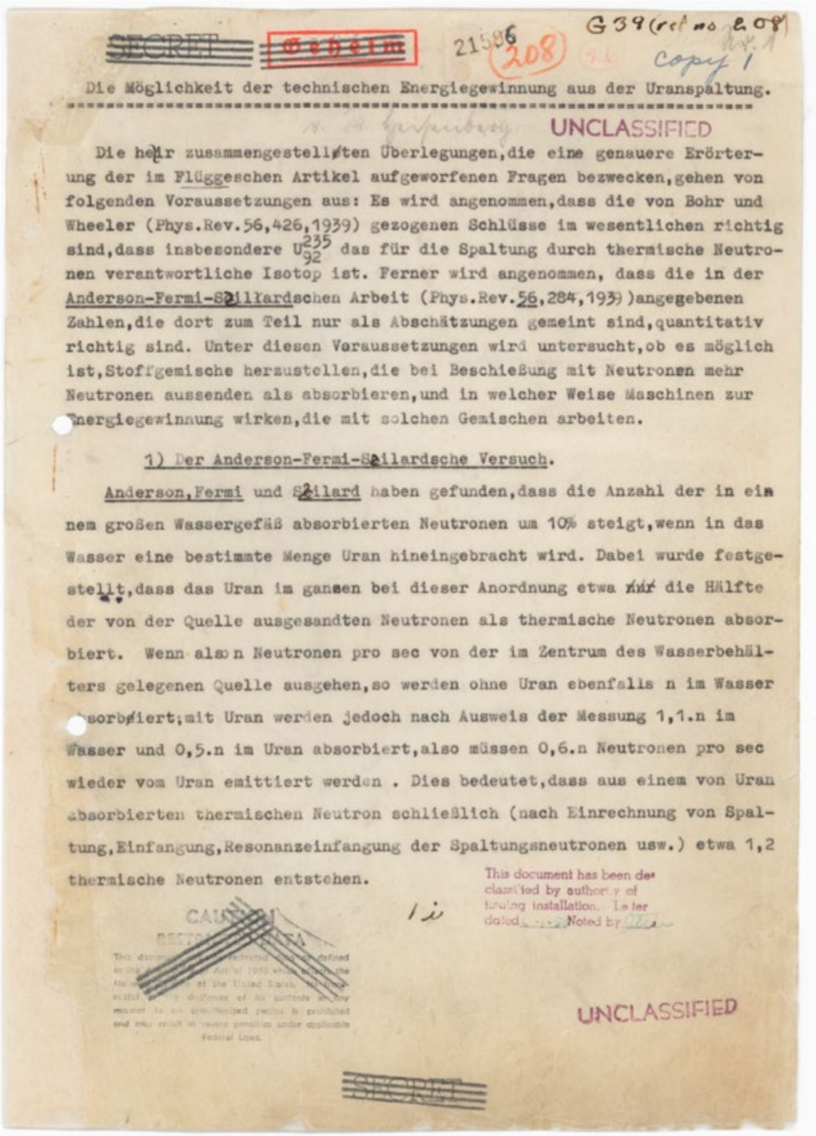
Contextual narrative

On 7 May 1946, the Allied Control Council Law No. 25 came into force. With this law, the Control Council strictly forbade West Germany any strand of research that had civil and military applications, which included nuclear physics (Müller 1990, vol. 1, 44). Yet, the West German chancellor Konrad Adenauer and his government did not want to be excluded from international developments and were not inclined to accept Allied restrictions in this field. After the ratification of the General Treaty (also: Germany Treaty) in 1952, which regulated the relationship between the Federal Republic of Germany and the Western Allies (France, Great Britain, and the USA), Chancellor Adenauer and the physicist Werner Heisenberg publicly pushed for the construction of a nuclear reactor. To connect to international developments, an organizational frame was necessary. To this end, Adenauer initiated the building of a body that was to prepare the nuclear energy industry. The ratification of the Bonn–Paris conventions in 1955 put an end to the Allied occupation of West Germany and freed the way for the civilian use of nuclear energy (Tiggemann 2010, 47 et seq.). The primary goal of the West German government was now to reduce the research backlog of more than a decade and to found structures to support nuclear energy. In the same year, the West German government decided to convene the German Nuclear Commission – though it was not responsible to the parliament, it functioned as an advisory body to the atomic minister (Gleitsmann 1987, 34 and 38). A driving motif to promote nuclear energy was the pronuclear, euphoric atmosphere in West Germany, but it was accompanied by a fear of possible energy shortages in the future, after the Technical University in Karlsruhe had predicted a coal shortage for the mid-1970s (Radkau 1983, 113).

The euphoric atmosphere in West Germany was partly inspired by the first international conference on the Peaceful Uses of Atomic Energy organized in 1955 in Geneva under the leadership of the United Nations. The Federal Republic undertook steps for international cooperation and was amongst the founding members of the European Atomic Energy Community (also known as Euratom) in 1957 (Stamm 1992, 39 et seq.). Finally, it created the legal basis for the construction and operation of nuclear power plants in Germany: in 1959 the Federal Government adopted the Atomic Energy Act on the peaceful utilization of atomic energy and protection against its hazards (Atomic Energy Act 1959, 814). In the same year, the German Atomic Forum was created. Following the US American model, it became the representative for the private sector and the public for the support of nuclear energy (Müller 1990, vol. 1, 198 et seq.). In 1961, the forum opened up for interested organizations, companies, and associations.

In the same year, the first nuclear power plant went online between Karlstein and Kahl at the border of Hesse and Bavaria, which heralded the start of nuclear power in West Germany as an industrial business. Soon German politicians spoke about a future that would solve all distribution problems through cheap atomic energy.

A phase of development and planning followed which went nearly unnoticed by the public. Physicist and Nobel laureate Werner Heisenberg in particular became a driving force of the nuclear sector. For him, a powerful nuclear industry was crucial to the overall economic competitiveness of West Germany, and he understood the forceful development of nuclear research centers as a necessary first step in that direction. His vision of building up a strong federal atomic program, however, remained contested, along with the question of siting nuclear research facilities. (Figure 1)



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Die Möglichkeit der technischen Energiegewinnung aus der Uranspaltung.

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Die hier zusammengestellten Überlegungen, die eine genauere Erörterung der im Flüggeschen Artikel aufgeworfenen Fragen bezwecken, gehen von folgenden Voraussetzungen aus: Es wird angenommen, dass die von Bohr und Wheeler (Phys.Rev.56,426,1939) gezogenen Schlüsse im wesentlichen richtig sind, dass insbesondere U^{235}_{92} das für die Spaltung durch thermische Neutronen verantwortliche Isotop ist. Ferner wird angenommen, dass die in der Anderson-Fermi-Szillardschen Arbeit (Phys.Rev.56,284,1939)angegebenen Zahlen, die dort zum Teil nur als Abschätzungen gemeint sind, quantitativ richtig sind. Unter diesen Voraussetzungen wird untersucht, ob es möglich ist, Stoffgemische herzustellen, die bei Beschießung mit Neutronen mehr Neutronen aussenden als absorbieren, und in welcher Weise Maschinen zur Energiegewinnung wirken, die mit solchen Gemischen arbeiten.

1) Der Anderson-Fermi-Szilardsche Versuch.

Anderson, Fermi und Szilard haben gefunden, dass die Anzahl der in einem großen Wassergefäß absorbierten Neutronen um 10% steigt, wenn in das Wasser eine bestimmte Menge Uran hineingebracht wird. Dabei wurde festgestellt, dass das Uran im ganzen bei dieser Anordnung etwa ~~nur~~ die Hälfte der von der Quelle ausgesandten Neutronen als thermische Neutronen absorbiert. Wenn also n Neutronen pro sec von der im Zentrum des Wasserbehälters gelegenen Quelle ausgehen, so werden ohne Uran ebenfalls n im Wasser absorbiert; mit Uran werden jedoch nach Ausweis der Messung 1,1.n im Wasser und 0,5.n im Uran absorbiert, also müssen 0,6.n Neutronen pro sec wieder vom Uran emittiert werden . Dies bedeutet, dass aus einem von Uran absorbierten thermischen Neutron schließlich (nach Einrechnung von Spaltung, Einfangung, Resonanzeinfangung der Spaltungsneutronen usw.) etwa 1,2 thermische Neutronen entstehen.

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Figure 1 Werner Heisenberg's report on the *Possibilities of Technical Energy Production from Uranium Fission* classified as 'secret'

Energy companies like Rheinisch-Westfälisches Elektrizitätswerk AG (RWE Power AG) or PreußenElektra, which paid for and operated the nuclear reactors, were especially critical of nuclear power because of the costs and the technical uncertainties involved.

For instance, their relatively new facilities for producing brown coal would have been shut down if they had changed to nuclear energy – something RWE firmly rejected (Tiggemann 2010, 62). They were reluctant to adopt a new and unproven technology and pleaded instead for renewable energy. As a result, Franz Josef Strauß's successor in the Atomic Ministry, Siegfried Balke, saw energy supply companies as opponents to his politics. He tried to use energy politics against the energy industry, for instance by keeping them out of the planning for the first atomic program (Radkau 1983, 116 et seq.). Until the end of the 1960s, RWE clearly gave preference to brown coal over nuclear energy. However, in 1968 the energy supply company staged a turnaround and took the lead in the German development of the nuclear industry by placing the order for Biblis A. Historians described the project as having set new standards in power plant construction worldwide (Tiggemann 2010, 63 and 176). The plant was built in the South Hessian municipality of Biblis and consisted of two units: unit A, with a gross output of 1,200 megawatts, and unit B, with a gross output of 1,300 megawatts. The pressurized water reactor Biblis A began operating in 1974. After the nuclear catastrophe in Fukushima in 2011, bloc A was shut down; however, bloc B was already in a scheduled revision and therefore did not have to be closed down.

In an effort to make a case against critics of the nuclear energy industry, the German government established major research centers in Karlsruhe and Jülich in 1956 and 1962 that soon became influential in European nuclear research and development. The plan to promote research to generate arguments against critics of nuclear energy worked only in part. This time, opposition came from civil society, especially women. Local women's associations in Karlsruhe were critical of the research centers because of the danger posed to citizens in a city with a high population density. The city of Karlsruhe had commissioned a survey that revealed that only 27 percent of interviewed women approved of the research centers, compared with 63 percent of interviewed men (Renn 1995, 762). The civilian and military use of nuclear power was a topic that frequently divided the sexes on the issue of quality of life. Green politician Petra Kelly expressed the opposing views of men and women on the military use of nuclear energy as follows: "[n]uclear war and war in general [is] a manifestation of the constant war between masculine and feminine values" (Women should push, 1984, no page numbers).

Not only women opposed research centers and nuclear sites, the 1950s was generally the time of the first protest wave in Germany. When the German government planned to equip the German army with so-called tactical nuclear warheads and launch sites for short-range missiles, 18 German nuclear scientists – including Nobel laureates Heisenberg, Max Born, Otto Hahn, Max von Laue, and Wolfgang Paul – opposed this with the Göttingen Manifesto of 12 April 1957. The proclamation pointed at the destructive power of these weapons and warned of the military and political consequences of nuclearization (Schirrmacher 2007; Lorenz 2011). The Campaign against Atomic Death formed in response to fear of the atomic armament of the German army and led to skepticism towards civilian nuclear facilities as well (Milder 2017). The decade also saw the foundation of critical nuclear energy non-governmental organizations, some of which were politically contested. One example was the World Union for Protection of Life (WSL), which became active in over 30 countries. The association was founded in 1960 by the Austrian writer, environmentalist, and former Nazi party member, Günther Schwab. Membership grew rapidly and from 1970 onwards, the WSL was an influential power in the growing ecology movement. For instance, the German WSL was one of the founding members of the Bundesverband Bürgerinitiativen Umweltschutz, which is the umbrella organization of all environmentally active citizens' initiatives in Germany. Due to its partly right-wing activities and members, the German WSL branch was banned from the international association in 1985 and dissolved in 2001 (Kirchhof 2011, 36 and 41; Engels 2006, 78 and 332). These first protests differed from later ones because protestors did not take direct democratic measures or cooperate transnationally.

These steps were taken for the first time in the mid-1970s with the protest against a power plant in the Badensian village of Wyhl. The actions are widely recognized as the starting point of the anti-nuclear movement in Germany and historians have interpreted them as a national site of memory deeply embedded in German culture (Rusinek 2003). Though – as explained above – this protest was not the first one, it did become an example to activists for later protests.

In 1973, Wyhl was chosen as the site for a nuclear power plant, which caused direct opposition. In the following two years, signatures and appeals against the construction of the nuclear power plant were submitted to the minister of the interior. When these actions did not affect the political decision, local people – who were transnationally supported – increased their opposition and occupied the construction site. In 1975, it was decided that construction should be interrupted, but the decision was reversed and the site in Wyhl was occupied once more. In March 1977, the administrative court withdrew the construction license for the plant but later initiated a process of second instance. In 1982, the minister president of Baden-Württemberg declared the construction of the nuclear power plant in Wyhl unnecessary and confirmed his decision five years later. In the end, the plant was never built (Engels 2003, 350 et seq.; Tiggemann 2010, 212 et seq.).

A few other projects played particularly critical roles in the public debate in West Germany. The (planned) building of reactors in Brokdorf, Kalkar, Wackersdorf, and Gorleben caused a further shift from optimism to pessimism over nuclear energy and triggered massive protests as well as violent disputes between activists and police. In 1975, 25,000 people took to the streets in Wyhl; in 1977, 40,000–60,000 people demonstrated at the site at Kalkar; and two years later, in 1979, 100,000 people joined the Gorleben track protest. Up until then, the rallies against nuclear facilities had been the biggest in West Germany's protest history (Mende 2011, 332).

Concerns about a light-water nuclear power reactor proposal at Brokdorf, near Hamburg, had become a public issue in November 1973 (the plans for it dated back to the late 1960s). But it was not until 1976 and 1977 – during the first construction phase – that opponents started to protest violently against it. The police had learned from their experience at Wyhl and wanted to avoid similar incidents at all costs. Shortly after receiving the permit for building the reactor, the police cordoned off the Brokdorf site which led to violent clashes between opponents and the police and a demonstration with 30,000 people a few weeks later. This promted a halt in construction that was justified by the lack of a disposal strategy for spent fuel. In 1981, construction continued and about 100,000 people demonstrated, causing a severe confrontation with police once again. More conflicts with the police followed in 1986, the year the Brokdorf nuclear power reactor eventually started operating (Glaser 2012, 12 et seq.).

In 1985 the Deutsche Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen mbH (German waste disposal company DWK) decided to build and operate a reprocessing plant in Wackersdorf, a municipality in the district of Schwandorf in Bavaria, Germany. When they started clearing the woodland, 30,000 people demonstrated, occupied the building site, and erected a hut village. After the Chernobyl nuclear power plant catastrophe in April 1986, the violent dispute between police and anti-nuclear activists reached its peak. A large number of initiatives – many organized and run by women – mushroomed, such as the group Mothers Against Nuclear Power (Figure 2), which took part in hearings against Wackersdorf (Blomeyer and Wurzbacher 2016; Wurzbacher 1988; Mütter 1988). Finally, the protesters were successful: the energy company Vereinigte Elektrizitäts und Bergwerks Aktiengesellschaft (United Electricity and Mining Corporation, VEBA) changed its politics and was no longer interested in the reprocessing plant, resulting in a building freeze in 1988.

The building of a radioactive waste disposal facility in Gorleben, Lower Saxony, which was planned as a future deep final repository for waste from nuclear reactors, also provoked massive protests. The decision to use Gorleben as site for storing nuclear waste came in 1977 under Chancellor Helmut Schmidt (SPD, Social Democrats) and Prime Minister Ernst Albrecht (CDU, conservatives). Before the decision was made, over one hundred salt domes had been considered. Most important were the geopolitical criteria, such as the sparse settlement at the border area close to East Germany. Protest against the decision arose early on and the site was given up as a final repository. Today the plant serves as an intermediate storage facility for waste from Germany's nuclear power plants, which is reprocessed in France and then sent back to Germany for final storage. Current protests against nuclear energy in Gorleben are directed at the annual transport of dry cask containers from France to Germany and continue to demand a huge police presence (Glaser 2012, 15; Khoo and Rau 2012, 156).

An interesting technological project that failed and later became an enterprise of the burgeoning leisure sector was the construction of SNR-300, a pilot-scale fast breeder reactor, in Kalkar. The project started in 1972 as an international collaboration. Built to produce 327 megawatts of electricity for the Rhineland, SNR-300 was a solution to limited uranium reserves in the Federal Republic and a means to become independent from energy imports in the near future. Criticism soon arose about the safety of the breeder and international demonstrations took place in 1974 and 1977. Experts expressed their concerns about the reactor coolant as well as the controlling process, and a four-year halt in construction was agreed upon. Even after the construction of SNR-300 was completed in 1985, the government of North Rhine-Westphalia did not authorize use of the building because of unforeseeable risks in operating the reactor. The shutdown of the project was announced in 1991, and the unused machines and facilities were transferred to reactors and production complexes in other countries. Finally, the reactor was sold and turned into an amusement park.

The transition from optimism to pessimism manifested in Germany's political landscape too. While the Social Democratic Party (SPD) strongly advocated nuclear energy as a trigger for technological and industrial modernization during the 1950s and 1960s, it switched sides and became a critic of nuclear energy in the 1970s. In 1998 – under the newly elected Social Democratic Party (SPD) Chancellor Gerhard Schröder – the red-green coalition decided to phase out nuclear energy within 20 years. The Christian Democratic Union (CDU) and Free

Figure 2 "Don't say you didn't know". Protest of the newly founded *Mothers Against Atomic Power* Initiative in May 1986 shortly after the Chernobyl accident happened. Munich, Marienplatz

Democratic Party (The Liberals, FDP) coalition government that was elected in September 2009 was committed to rescinding the phase-out policy. Yet, after the Fukushima Daiichi nuclear disaster in 2011, Chancellor Angela Merkel announced the closedown of all German power plants by 2022. Parliament and most German politicians approved of the moratorium.

Women were often at the forefront among critical citizens and since the 1970s they had raised their voices louder than ever. Many of them argued that there was an essential connection between the suppression of women in a patriarchal society and the subjugation of nature, resulting in its damage. They pointed out that humans are no longer an integral part of the environment and claimed a new concept of nature focusing on intuition, emotionality, and spirituality (Thiessen 2010, 37–44). The Protestant theologian, political scientist, and colleague of Petra Kelly, Eva Quistorp, was one of the first women to talk publicly about this ecofeminist theory when she gave a presentation entitled “Women and Mothers against the Destruction of the Natural World” at the Free University of Berlin in 1976 (Quistorp 1979, 152). Within the ecofeminism school of thought, positions based on difference feminism theory emerged, elevating gender differences to a defining category. The theories implied differences between men and women with regard to their biological and social gender but claimed the principle equality between genders. This newly formulated political trend within the broader feminist movement presented female qualities as non-deficient and aimed at putting an end to the perception that women were an aberration from the male norm. It created a positive reference to shared femaleness and became a source of emotional strength and legitimization for political activities in the women’s peace movement of the 1980s (Flaake 2005, 158–175). In particular, the Chernobyl nuclear power plant catastrophe in April 1986 led to an upswing of intensified debates in Germany. Women highlighted the differences between the sexes and founded new initiatives, informed themselves and others about the risks involved in the civilian and military use of nuclear power, published leaflets, gave speeches, and organized conferences. One example was the international congress “Women and Ecology: Against the Feasibility Delusion” that took place in Cologne in October 1986 and was organized by feminists in the local area, by the Greens, and by the autonomous women’s movement (Lenz 2010, 855).

Historiography has given various reasons why the opposition against nuclear power was generally strong in Germany and also violent at times. Historians found answers in Germany’s national socialist past, which might have resulted in a strong skepticism towards the authorities as well as a lack of religious influences in the movement, as can be found in the United States. Others emphasize society’s criticism of cost-benefit analyses. First, nuclear opponents feared future generations' accusations that their ancestors had failed to act against the atomic industry and had become its accomplices instead; children and grandchildren had made similar arguments regarding the country's national socialist past. Those who did not wish to be seen as traitors and followers had a duty to oppose nuclear power. Additionally, large parts of the population frequently mistrusted the state and the energy industry, and faith in the problem-solving strategies of experts and academics faded. Up until then, loyal state citizens had had experiences that had turned their trust into skepticism (Interview Szepan). In particular, the suspicion that state authorities would bend practice and law to favor the interests of nuclear energy advocates also supported doubts against the state within non-critical circles. They saw a connection between the extension of atomic energy and democratic deficits and argued that the atomic lobby lacked transparency as well as honesty. Opponents perceived the relationship between the atomic industry and the population as one of traitors and victims. This mistrust in the truthfulness of state and the nuclear industry justified militant actions for some activists. Additionally, the police's brutal responses to militant acts and the obvious intention of some politicians to criminalize dissidents only increased skepticism and suspicion of authorities in politics and the economy in Germany. (Schüring 2015, 89 et seq.; Tompkins, *Grassroots* 2016, 117; Mende 2011, 330 et seq.).

Second, a different understanding of civil disobedience, as can be found in the US, is also emphasized. The historian Michael Hughes argues that non-violent protest in America has two origins that were missing in Germany and might have resulted in a greater openness to violent actions. According to Hughes, these influences stemmed from the American author and philosopher Henry David Thoreau's argument for disobedience to an unjust state, as well as from the Christian roots of the US American Civil Rights movement (Hughes 2014, 236–253). Violence as a means of political dispute could be found especially in leftist political activists, such as in communist cadres as well as the so called Sponti scene (Mende 2011, 333 et seq.). Third, resistance against nuclear power plants also expressed a critique of large-scale technology. In the opinion of many citizens, the costs of the facilities far exceeded the benefits, and tend to be under-estimated (Engels 2006, 348).

On a global scale, different environmental, peace, disarmament, and anti-uranium movements inspired each other worldwide. This was possible through a significant transfer of ideas conveyed through activists, politicians, experts, social organizations, and the media, which functioned as transmitting agents for relevant information, ideas, and values. Transfer of ideas did not necessarily result in cooperation between ecological groups on a broader scale. There were a number of reasons why social movements did not always find it easy to cooperate. For one thing, there may have been too many social movements to be united under a single cause, sometimes even in one nation state. Moreover, despite common ideologies and views, each movement had a different focus, and the lack of a common "language" hampered this coalition building further. Another reason is that it was difficult to maintain international contacts and to travel, both of which were vital to transnational collaboration. Travel distances and costs generally prohibited many activists from international involvement and transnational cooperation, at least until the last quarter of the twentieth century. Finally, the internal structure, different strategies and choreographies, cooperative culture, and diverse social milieus of the environmental action groups could sometimes lead to misunderstandings and be an obstacle to coalition building between groups and movements. Cooperation worked slightly differently at nuclear sites that were close to borders, because some of the "obstacles" described above only applied to a minor extent. Where nuclear sites were close to two or sometimes three different countries, people of diverse nationalities usually had similar interests. Furthermore, since the travel distances were rather minimal, it was easier to join and support local protests. This was the case in protests against nuclear plants in Wyhl and Cattenom (interview Avena) where French and German activists worked together, or in Kalkar, as the common protest of Dutch and German activists shows (Kirchhof and McConville 2015, 332–333; Tompkins, *Grassroots* 2016, 131 et seq.).

While activists learned from each other how to organize protests more effectively, government officials and police chiefs too learned from confrontations, as the Wyhl case shows. Since the interactions between activists and the police became increasingly violent, the latter developed special strategies to protect reactor sites and hinder activists from lasting occupation (Milder 2014, 197).

Main Actors

Government, as the main funder of research and development, has been a strong proponent of nuclear power until recently, specifically through various ministries such as the Federal Ministry of Nuclear Affairs, which was founded in 1955, or the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, which was founded in 1986 under the name Federal Ministry for the Environment, Nature Conservation, and Reactor Safety. Bodies like the Reactor Safety Commission, which was set up by order of the Ministry of Nuclear

Affairs in 1958, also had a strong interest in the sector. Responsibility for licensing the construction and operation of all nuclear facilities is shared between the German Federal Government and the federal states, which confers something close to a power of veto to both.

Science has been another driving force of the nuclear sector. The physicist Werner Heisenberg, Nobel laureate and science advisor to Chancellor Konrad Adenauer, opted for an early and strong engagement in atomic research to pave the way for industrial activities and international collaboration (Carson 2010; Carson 2002). Allied restrictions in applied nuclear research and technology were only lifted in 1955 when West Germany received sovereignty, but in the early 1950s a number of both large-scale nuclear research centers and university-based research reactors had already been founded, including big science establishments in Karlsruhe, Jülich, Geesthacht, and Munich (Rusinek 1996; Oetzel 1996; Interview Popp 2016). When the foundational mission of these centers came to an end in the 1970s, they diversified into many other fields of both basic and applied science, including renewable energies. But up until today, the centers have kept a foot in the nuclear realm and continue to conduct research and training, particularly in nuclear safety.

Private companies have been vital in the construction of German reactors. In the foundational period of the 1950s, however, the energy industry was hesitant to engage in the nuclear sector and it needed the state to set the scene (Radkau 1983). Once established, the nuclear industry became the core proponent of nuclear energy and continuously attempted to enlarge nuclear markets both domestically and abroad. The engineering company Siemens and its subsidiary company Kraftwerk Union (KWU) had a monopoly position in developing nuclear power plants for Germany for decades, until after the Fukushima nuclear disaster in September 2011 when Siemens withdrew from the nuclear industry. At the same time, it concluded its cooperation with the global leader AREVA – a French multinational group specializing in nuclear power and renewable energy, whose German branch is in Erlangen (Interview Schuch and Meyer zu Schwabedissen). This leaves four remaining nuclear energy companies: E.ON Kernkraft GmbH (the biggest German energy company), Vattenfall Europe Nuclear Energy GmbH (the Swedish company opposed the phasing out in Germany, which gave it a bad image), RWE Power AG (critical of nuclear power in the 1950s for cost reasons and pleaded for renewable energy), and EnBW Energie Baden-Württemberg (the third-biggest energy company, which suffered heavy financial losses after the phase out because of strong investments in nuclear power). The state subsidized or gave indirect financial benefits for the construction and operation of nuclear plants (at the expense of taxpayers). Thus, some critics point out that the costs for nuclear energy had been held low artificially with the help of subsidies worth billions (AtomkraftwerkePlag – Atomlobby Konzerne and Atomlobby Subventionen).

Professional associations including the German Atomic Forum (founded 1959) and the Nuclear Society (founded 1969) often have strong formal and informal links to each other. For example, the former is a member of the latter organization and supports it financially. Moreover, there are links to politics, e.g. well-known institutions funded by the Federal Government, such as the Deutsche Bahn AG, the Helmholtz Center Munich and Berlin, and the Max Planck Institute of Plasma Physics, to name a few, are members of the German Atomic Forum and the Nuclear Society, among others, and support them through membership fees. Further associations are: Bürger für Technik (BfT), Energie-Fakten.de, Europäisches Institut für Klima und Energie (EIKE), Informationskreis KernEnergie (IK), Initiative Neue Soziale Marktwirtschaft (INSM), Internationale Länderkommission Kerntechnik (ILK), Nuklearia e.V., Reaktor-Sicherheitskommission (RSK), Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), TÜV SÜD, Wirtschaftsverband Kernbrennstoff-Kreislauf und Kerntechnik (WKK), and Women in Nuclear (WiN) (Government's reply to minor interpellation 2014).

Trade Unions supported the use of nuclear energy for decades. When the "green" nuclear opponent Frank Bsirske became head of the trade union Vereinte Dienstleistungsgewerkschaft (Ver.di) in 2008, the new service union took a critical stance on this technology. At around that time, the Union for Heavy Industry, Engineering, and Electronics (trade union IG Metall) started to cooperate with the anti-nuclear movement as well because they saw a future for jobs in the field of renewable energies. After the nuclear disaster in Fukushima in 2011, the head of Trade Union of Mining, Chemicals and Energy Industries demanded sufficient alternative energies, but no longer questioned the phasing out of nuclear energy (von Appen 2011, 36; AtomkraftwerkePlag – Gewerkschaften und Atomkraft).

In the 1970s, **societies** became increasingly skeptical of nuclear power. In Germany the controversy was carried out at all societal levels and integrated intermediary social groups but also experts that founded alternative ecological research institutes; like the Freiburg Institute for Applied Ecology (Öko-Institut). It was founded in 1977 and is one of the most important institutes in its field in Germany. Protests against nuclear sites took direct democratic measures, engaged in transnational cooperation, and resorted to extreme violence at times. Opposition to the construction of a power plant at the Badensian village of Wyhl was carried out by local inhabitants, especially wine farmers, but transnationally supported. For the first time, actions became especially violent with protests against the light-water reactor in Brokdorf, which caused "civil-war-like confrontations between police forces and opponents of the project" (Glaser 2012, 12; also: Kirchhof 2013, 2015; Kirchhof and Meyer 2014; Mende 2011; Milder 2014; Tompkins, *Better* 2016). The movement finally culminated in a new party, the Greens which was founded in 1980.

Figure 3 1986: Police before reactor 2 in Brokdorf

Showcase

Wonderland Kalkar

The Kalkar project started as an international collaboration in 1972 when the Belgian-German-Dutch Fast Breeder Nuclear Reactor Ltd. was founded in Essen. The company instructed the Siemens subsidiary Interatom to carry out the construction of fast breeder sodium cooled nuclear reactor (SNR-300) in Kalkar, North Rhine-Westphalia, Germany and the foundation stone laying ceremony took place in 1973. The site was supposed to comprise a total area of 17,000 square meters with an output of 300 megawatts. The motivation to build the reactor was the limited uranium reserves in the Federal Republic of Germany. Advocates of atomic energy hoped that by building the breeder, minerals could be utilized efficiently and Germany could cease to be dependent on energy imports in order to generate electricity in the foreseeable future. The Rhenish-Westphalian Power Plant (RWE, which in 2000 merged with Vereinigte Elektrizitätswerke Westfalen, or VEW) originally chose the North Rhine-Westphalian village of Weisweiler as site for the fast breeder. But it seemed too risky to build a reactor in the broader Aachen city region because of its density of population. The idea was given up and the sparsely populated area around Kalkar was chosen instead (Marth 1992, 43). Soon criticism arose about the building of the fast breeder, based on doubts about the safety of nuclear energy, and in 1974 around a thousand people, predominantly from the Netherlands, took to the streets. A mass rally three years later was attended by 50,000 people (Tompkins, *Grassroots* 2016, 129) (some authors speak of 60,000 people [Mende 2011, 332]) from France, the Netherlands and West Berlin. The police presence is regarded as the biggest in the history of the Federal Republic of Germany. The police were extremely violent and many demonstrators felt they were treated like terrorists. The writer, feminist, and co-founder of the German Green Party, Jutta Ditfurth, remembers how activists on their way to Kalkar were stopped by the police so that many could not reach their destination:

> A commuter train from Duisburg to Kleve was stopped in open country by federal border guard helicopters. Federal border guards and police officers with truncheons, gas masks, tear gas canisters, and submachine guns surrounded the train and harassed the passengers. … They stopped our buses and closed motorways across the whole state. In their large federal border guard helicopters, they flew low over demonstrators, landed, beat them up, and flew off (Mende 2011, 337).

According to the former Foreign Minister and co-founder of the Green Party Joschka Fischer, the events at Malville and Kalkar signaled the end of this form of extra parliamentary mass resistance against the construction of nuclear power plants (Mende 2011, 337).

Another example further demonstrates that the government's treatment of members of the anti-nuclear-movement, or even of people who were only suspected to be opponents of nuclear power, was reminiscent of defense against terrorists. The German engineer Klaus Traube was managing director of Interatom, which had built the nuclear power plant SNR-300 in Kalkar. Originally a proponent of nuclear power, Traube reconsidered his views in the early 1970s after having read the Club of Rome's *The Limits to Growth*. When the German secret service suspected (falsely) that he had passed on secret information to the Red Army Faction (RAF), they illegally wiretapped Traube's apartment and he lost his job because the Federal Intelligence Service (Bundesnachrichtendienst or BND), one of the three German secret services, informed his employer about the issue. The illegal operation was uncovered in 1977, Traube was cleared of all charges, and the government was plunged into a crisis, as a result of which the then Federal Minister of the Interior, Werner Maihofer, was dismissed (Mrusek 2011).

The anti-nuclear movement's opposition rose even more in the coming years, especially with the impact of the accident at the Three Mile Island nuclear power plant in the USA in 1979. Two court proceedings were launched against Kalkar, the second of which was the biggest in the history of the Federal Republic of Germany. Engineers that were involved in the process calculated that statistically every five years a "GAU" (a German acronym for worst-case scenario) would be a possibility at Kalkar (Kalter Kaffee 1984, 78; interview with Szepan 2016). Moreover, experts expressed concerns about the coolant and the control process that was considered to be too difficult. On the one hand, a Bethe-Tait accident (Bethe 1956) could not be ruled out; on the other hand, liquid sodium was used for cooling, which was chemically especially aggressive. In contrast to the low-enriched uranium of conventional reactors, it was possible to also produce atomic bombs with the uranium that was used in the breeder, as Jo Leinen – leading figure of the anti-nuclear movement, later Environment Minister of Saarland – pointed out. Because the technology would have to be exported to be profitable, countries which had not had atomic bombs before would now get the chance to gain access to them (Bretschneider 2011). Since the opponents of the construction lodged a constitutional complaint before the Constitutional Court, the German parliament's commission of inquiry ordered that construction be interrupted for four years in light of the safety concerns. Because of the difficulties involved in construction, the costs of the project also rose. From the initially planned 500 million marks (today ca. 256 million euros), the price rose to 1.7 billion marks. In the end the whole project cost seven billion marks, which was 14 times higher than the original price (Meyer-Larsen 1981). When the North Rhine-Westphalian social-democratic/liberal coalition endorsed the anti-nuclear course, the Minister of Economic Affairs, Horst Ludwig Riemer (FDP), blocked the partial construction licenses, which caused a crisis.

The construction of SNR-300 was finally completed in 1985 and the reactor was put into partial operation: the sodium coolant was running through the coolant loop and the reactor was ready to receive nuclear materials. The operational costs totaled 105 million marks (today 93 million euros) annually. Against the wishes of the Federal Government and the christian-democratic/liberal coalition, the state of North Rhine-Westphalia (which was the authority in issues concerning nuclear power) rejected the authorization to begin operations at the plant. The Minister of Social Affairs and Labour of North Rhine-Westphalia, Friedhelm Farthmann (Social Democratic Party), who was responsible for the planning permission, argued that commissioning the plant was irresponsible because the risks were ultimately not calculable. According to the atomic law the Federal Government was able to enforce the authorization, but did not want to carry the responsibility for the controversial SNR project alone. One reason for this decision was the disaster in Chernobyl that had happened in April 1986 and caused the atmosphere in West Germany to become increasingly critical of nuclear energy (Interview Avena 2016). No politician wanted to make unpopular decisions and risk negative results in the upcoming elections for the German parliament in 1987. Instead, the German government decided not to take SNR-300 into operation at that time. In the coming years, the applications underwent time-consuming examinations. According to SNR advocates the whole process was delayed so long that the closing down of the reactor was unavoidable. Moreover, since energy consumption had risen slower than expected, electricity suppliers were no longer interested in the commissioning of the reactor. The termination of the project was announced by the then German Federal Minister of Education and Research, Heinz Riesenhuber, on 21 March 1991. The reasons for this decision were a) the certain radioactive contamination of system parts when commissioning the reactor which b) would cause high costs and preclude further use of the complex buildings. The mega project, thus, had developed into a huge investment failure.

Successively the new and never used equipment and machines were sold because demolishing the whole complex would have cost another 75 million euros and was economically not possible. The owner of the reactor core was the RWE

Power AG, but the company had no license for fuel which was enriched with plutonium. Therefore, the plutonium was integrated into so-called MOX fuel elements (MOX = mixed oxide fuel which is an alternative to the low-enriched uranium [LEU] fuel used in the light-water reactors) in La Hague's reprocessing plant and eventually used in traditional nuclear power plants. Moreover, 12 unused blanket fuel assemblies that contained depleted uranium were transferred to the United States. Here the mostly decommissioned nuclear production complex, Hanford Nuclear Reservation on the Columbia River, took the assemblies in.

The German government sold the complex for 2.5 million euros at a public auction in 1995 to the Dutch entrepreneur Hennie van der Most, who converted it into a leisure park. The price was rather low for an object that had cost multiple times that to build, but since the German government did not want to cover the cost of dismantling the nuclear facilities at Kalkar itself it agreed to the price. At first the amusement park was called "Kernwasser Wunderland" ("Corewater Wonderland"), but this name probably reminded guests too much of the project's original purpose, so it was renamed later as Wunderland Kalkar ("Kalkar Wonderland"). The space, originally intended to become one of Europe's landmark nuclear projects, is now open to the general public. Besides hotels to stay in overnight, and bars, pubs, and restaurants for culinary enjoyment, the "wonderland" provides a family amusement park with climbing walls, white-water rides, flying carousels, and merry-go-rounds offering fun and adventure for the whole family (Kohlrausch and Trischler 2014, 229 et seq., and Wunderland Kalkar Webpage).

Figure 4 Amusement park *Wonderland Kalkar with cooling tower*

Events

German atomic program – first nuclear research center

Who was involved: Federal Government in general and the Federal Ministries of Atomic Affairs and Economics in particular, state governments of Bavaria and Baden-Württemberg, communities of Garching, Munich, and Karlsruhe, German Research Foundation, technical universities of Munich and Karlsruhe, atomic physicists, and NATO.

When and where did it take place: In the years 1952 to 1957 in the states of Baden-Württemberg and Bavaria and in the communities of Garching, Munich, and Karlsruhe.

What type of process was it – changes over time: Formation of nuclear research infrastructure and science policy process. When the Allied restrictions on nuclear science and technology seemed to come to an end in 1952, the German Research Foundation established a committee on atomic physics headed by the renowned physicist Werner Heisenberg. As early as November 1952, the commission demanded the establishment of a federally funded nuclear research center. Heisenberg, who worked in close collaboration with Chancellor Konrad Adenauer and became an informal advisor of the Federal Government, saw his hometown of Munich as the only possible location for the first German nuclear reactor station. He presented his ideas for a research reactor that would run on natural uranium, and thus not require US uranium enrichment facilities, to the Federal Minister for the Economy, Ludwig Erhard. At the same time the state of Bavaria was improving its chances of being chosen as the reactor site by establishing the subject of nuclear physics at the Technical University of Munich. The driving force there was the physicist Heinz Maier-Leibnitz (Carson 2002, Carson 2010, Gleitsmann 1988, Eckert 1999, Trischler 2015). What followed was an intensely fought competition between the state governments of Bavaria and Baden-Württemberg with the cities of Munich and Karlsruhe with their respective technical universities as candidates for the siting of the federal reactor station. When the Federal Government finally decided on Karlsruhe, it took into consideration a veto by the NATO Supreme Allied Commander Europe, who favored a site more distant from the Iron Curtain than Munich.

While Munich ultimately lost out to Karlsruhe in the contest for the reactor, the Max Planck Society came up with a compensatory solution that enabled Heisenberg to save face by accepting the Bavarian offer to move the Max Planck Institute for Physics from Göttingen to Munich. In addition, Bavaria was compensated with a light-water reactor for research based in Munich (Forschungs-

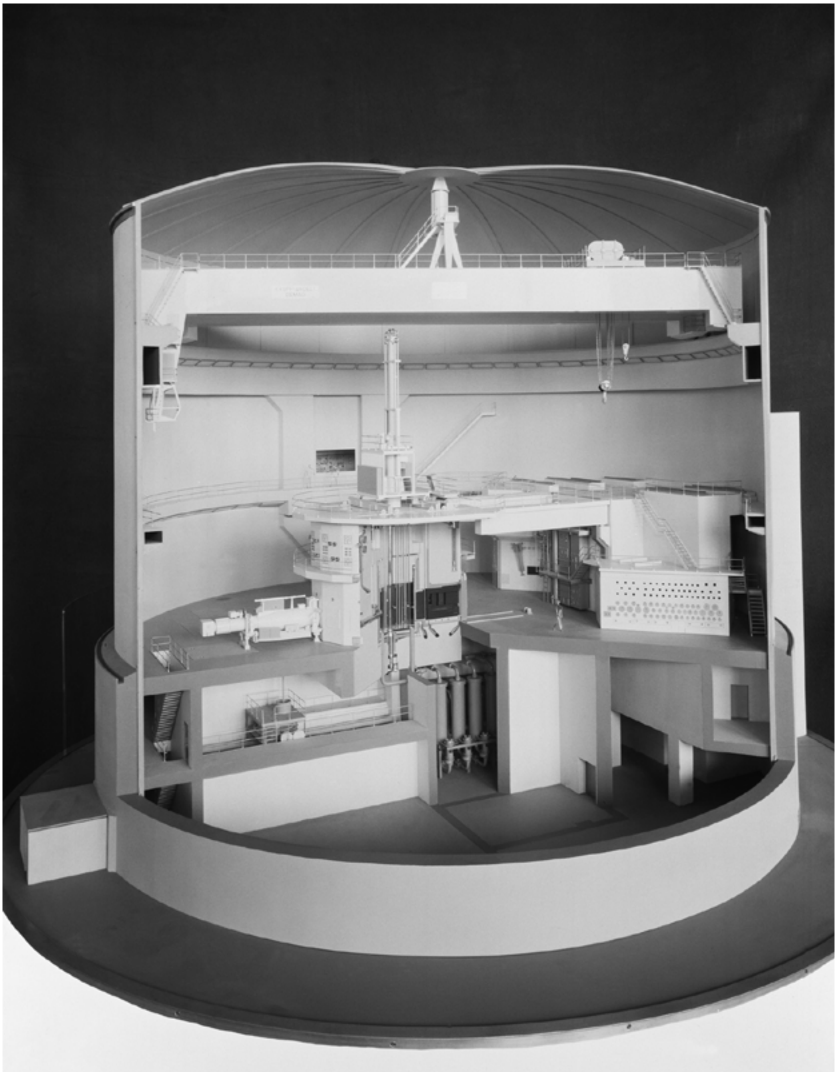

Figure 5 Model of the first research reactor in Karlsruhe

reaktor München, or FRM), headed by Maier-Leibnitz and administered by the Technical University of Munich. It began operation in Garching, near Munich, in October 1957 as the first German nuclear reactor and was quickly followed by a rapidly expanding research infrastructure of reactor (Figure 5) stations, including the big science centers at Karlsruhe, Jülich, Geesthacht, and Hamburg.

Evaluation of engagement events: The intervention of the NATO Supreme Allied Commander Europe in the siting conflict points to the interrelations of the civil and military dimensions of the nuclear sector. Although the scientific community tried hard to present nuclear science as a strictly civilian endeavor, not least to strip it of its historical origins in the so-called Uranverein (a project to develop nuclear weapons) under National Socialism, military rationales did play a substantial role in West Germany's early nuclear history (Kelleher 1975; Cioc 1988; Küntzel 1992; Hanel 2015).

Relevant documents: articles in science and engineering journals, media reports in e.g., Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, Federal Archives of Germany (German Atomic Program), State Archives of Bavaria and Baden-Württemberg, Archives of the Deutsches Museum (Papers of Heinz Maier-Leibnitz), Archives of the Max Planck Society and the Max Planck Institute for the History of Physics, State Archive Karlsruhe (GLAK), interview with the head of the Research Center Karlsruhe, Manfred Popp.

Civil society interaction – the Wyhl example

Who was involved: Federal State Government of Baden-Württemberg, Federal Ministry of the Interior, Kraftwerksunion (subsidiary of Siemens and AEG, a company that built nuclear power plants), planners, and activists.

When and where did it take place: In the years 1972 to 1977 and 1982 to 1987 in the state of Baden-Württemberg and in the community of Wyhl. Court cases took place in the cities of Fribourg and Mannheim.

What type of process was it – changes over time: Public participation and public communication. Before Wyhl was chosen to be the site for a nuclear power plant, politicians and planners considered the community of Breisach in the southwest of Germany as a possible site which – in the summer of 1972 – caused direct opposition because local farmers and wine growers expected negative environmental effects caused by emissions from the planned wet cooling towers. The Federal State Government did not want to risk the coming state elections and put the plans on ice. A year later it became publicly known that a new site in Wyhl had been found, which was only a few kilometres away from the original site and caused direct opposition again, this time well-organized. In 1973 and 1974 some 100,000 signatures and appeals against the construction of the nuclear power plant were submitted, including to the Federal Minister of the Interior, who at that time was Werner Maihofer (FDP, liberals). This did not change the political decision at first and on 17 February 1975 the construction of the first reactor was started even though the final license for the building of the nuclear power plant had not yet been granted. This provoked opposition again, mostly from local people, many of them wine farmers, who spontaneously occupied the site and were supported in their resistance by activists from the nearby town of Fribourg. Crucial to this resistance was the successful fight against the erection of a lead chemical plant in Marckolsheim in neighboring French Alsace on the other side of the river Rhine. On 21 March 1975 the administrative court ruled that construction should be interrupted. This decision was overturned half a year later after an objection made by Minister President of Baden-Württemberg, Hans Filbinger (CDU, conservatives). In autumn 1976 some 1,000 inhabitants demonstrated against Filbinger. Because the preparations for construction continued and site electricity connections were installed, the site in Wyhl was occupied by protestors again. In March 1977 the administrative court withdrew the construction license for the plant. But two years later the administrative court of Baden-Württemberg opened up a second case. In 1982 the court of justice decided again that the construction of the nuclear power plant was legal and caused a rally of 30,000 opponents. Filbinger's successor as Minister President of Baden-Württemberg, Lothar Späth (CDU, conservatives), declared that the construction of the nuclear power plant in Wyhl would not be necessary before 1993 and in 1987 he reconfirmed this decision, stating the plant would not be needed until the year 2000. The plant was never built and was turned into a nature reserve in the mid-1990s instead (Engels 2003).

Evaluation of engagement events: Wyhl has been interpreted by historians as a national site of memory deeply embedded in German culture (Rusinek 2003). The protest against the possible nuclear site in Wyhl was not the first protest against nuclear power in Germany, but the protest structures that were developed here are widely recognized to have served as an example for the West German environmental movement in later protests. Fribourg in Baden-Württemberg, the so-called green city, is a leader in environmental protection, renewable energy, and sustainability today. It produces less waste and consumes less water than comparable cities, and is leading in solar energy research. The founding of certain related institutes was inspired by the environmental movement's protests; the Institute for Applied Ecology, founded in 1977, is one of the most important institutes in its field in Germany.

Relevant documents: newspaper articles, e.g., in Die Zeit (Kühnert 1977), reports by German non-governmental organizations, e.g., BUND (BUND 2014), film documentaries (Nabel 2013), Federal Archives in Koblenz, Archive for Social Movements Fribourg, protest flyers and calls to protest, squatting journal *Was wir wollen*, archive of the Bundesverband Bürgerinitiativen Umweltschutz, Bonn.

Civil society interaction – the Wackersdorf example

Who was involved: Bavarian State Ministry for Regional Development and Environmental Questions (StMLU), Deutsche Gesellschaft zur Wiederaufbereitung von Kernstoffen mbH (DWK), cabinet, police, activists.

When and where did it take place: In the years 1980 to 1988 in Bavaria, especially the municipality of Wackersdorf in the district of Schwandorf.

What type of process was it – changes over time: Public participation and public communication. In 1980 the Bavarian State Ministry for Regional Development and Environmental Questions was authorized by the cabinet to find a site for a reprocessing plant (Wiederaufarbeitungsanlage, WAA). Two years later the DWK made an application to the StMLU for the granting of a nuclear licensing procedure for the construction and operation of a WAA in Wackersdorf. Even though other possible sites were debated, Wackersdorf was chosen because a "high potential of protest (…) [was] not to be expected" (Schardinger 2012, 18). In 1985 the DWK finally decided on Wackersdorf as appropriate location for the construction site and announced the development plan. After the clearing of the woodland had started, a major demonstration with 30,000 people took place in Wackersdorf. Demonstrators occupied the building site, erected a hut village, and called it "Freies Wackerland" (free Wackerland) (Knoll 2006). Citizens' initiatives, such as the Mothers Against Nuclear Power, raised objections to the reprocessing plant at a hearing in Neunburg. Here, they claimed for themselves and their families, especially their children, the fundamental right to life, health, physical integrity, and free development of their personality, which they did not see as being guaranteed if the reprocessing plant was built (Wurzbacher 1988, 1). The objections had to be handed in by a specific deadline to the approving authority, in that case the Bavarian Ministry of the Environment, which invited the people who protested to the hearing. The previous speaker before the women's initiative at the hearing was Robert Jungk, author of the influential book Der *Atom-Staat* (The Nuclear State). The audience the "Mothers" spoke to consisted of the approving authority, who were in favor of the reprocessing plant, representatives of the DWK, who had proposed the building of the reprocessing plant, and experts such as radiation biologists, who were consulted by the approving authority to justify factually and technically the envisaged authorization. As Karin Wurzbacher, member of the Mothers Against Nuclear Power reports, the atmosphere in the hall was "in the beginning bored – now we patiently endure the 'Mothers' and then we call it a day and [the men in the audience] showed a friendly face. In the end they were probably impressed. The representatives of the DWK showed no emotions whatsoever, they just reported their prepared answers" (Blomeyer and Wurzbacher 2016 and Wurzbacher 1988).

Up until the Chernobyl nuclear power plant catastrophe in April 1986 the Bavarian state government kept proclaiming publicly that hazards were not to be expected, either from the reprocessing plant or from any other nuclear power plant. The Chernobyl disaster – the so-called Super-GAU – then led to the peak of the violent disputes between police and anti-nuclear activists. West German police armed with stun grenades, rubber bullets, water cannons, CS gas, and CN gas were confronted by demonstrators armed with slingshots, crowbars, and Molotov cocktails at the site of the nuclear reprocessing plant in Wackersdorf (Germans 1986). Finally, the energy company VEBA changed its policies and was not interested in the reprocessing plant anymore. Additionally, the prominent advocate of the reprocessing plant, the Bavarian Minister President Franz Josef Strauß, had died, so the building plans were frozen in 1988.

Evaluation of engagement events: The plans for the plant were abandoned in 1988. It is still unclear whether protests, plant economics, or the death of Minister President Franz Josef Strauß, a strong proponent of the plant, in 1988 led to the decision (Isenson 2009).

Relevant documents: media reports in Süddeutsche Zeitung, Frankfurter Allgemeine Zeitung, Tageszeitung, Die Zeit, Der Spiegel, interview with the head of the energy company VEBA (Walraff 1989), film documentary about Wackersdorf (BUND 2015), printed papers of the Bavarian state parliament (Final report of the committee on Wackersdorf 1986), documents in the archive of the initiative Mothers against Nuclear Power, photographs of protests organized by the member of the initiative, Cornelia Blomeyer, statements about and transcripts of appeals against Wackersdorf by Cornelia Blomeyer and Karin Wurzbacher, report by Thea Bauriedel about contemporary experiences in Wackersdorf, documents in the archive of the Deutschen Gesellschaft für die Wiederaufarbeitung von Kernbrennstoffen (DWK).

Civil society interaction – the Gorleben example

Who was involved: Politicians, activists, German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), police, Federal Agency for State Protection and Counter Terrorism, Brennelementlager Gorleben GmbH (a subsidiary of the Society for Nuclear Services, GNS, which is owned by the energy companies E.ON, RWE, and Vattenfall Europe).

When and where did it take place: village of Gorleben in the district of Lüchow-Dannenberg (Lower Saxony). Controversies since 1977 up until recently, especially then when there are cask transports to the site in Gorleben.

What type of process was it – changes over time: Public participation and communication process. The only controversial nuclear project that still has relevance today in Germany is the repository site near the village of Gorleben (Lower Saxony, former West Germany). The decision for a storage site for nuclear waste came comparatively late. In the beginning the government did not see need for action to create a final repository because the quantity of waste was relatively small. For instance, high level waste did not exist because the reactor's fuel elements were brought back to the countries they came from. In cases where high-level waste was produced, the government planned to reduce the volume by reprocessing it and keep an open mind about further technological developments instead of deciding on certain methods just yet (Tiggemann 2010, 121; Müller 1990, vol. 1, 525). Germany and other countries considered different ways of storing radioactive waste. Ideas that were considered and/or debated were storage in space, in ice caps on earth, or in the sea. All of these concepts were contested and the Federal Republic decided to concentrate on disposal onshore in salt deposits. Because of the existing salt domes in Lower Saxony, the government considered a site for storage in this state. To this end, in the years 1967–1978 it tested the former salt mine Asse II in the Asse mountains of Wolfenbüttel for research purposes as a deep geological repository for radioactive waste (Tiggemann 2010, 126 et seq.).

In the end the government decided in favor of storing nuclear waste at the Gorleben site, a decision that came about in 1977 under Chancellor Helmut Schmidt (SPD) and Prime Minister Ernst Albrecht (CDU, conservatives). At the site, there exists today:

1. a storage unit for radioactive waste which emits faint heat;
2. an interim storage unit for dry cask storage;
3. a conditioning plant (and a pilot plant in a salt dome).

Figure 6 Colourful Protest in the hut village *Free Republic of Wendland,* Lower Saxony 1980

1 The salt dome was intended to become a long-term storage plant for different kinds of radioactive waste and is run by the German Society for the Construction and Management of Long-Term Waste Storage Units (DBE mbH), but at present this use is still controversial and it has not yet been finally decided upon. It was the then Minister President of Lower Saxony Ernst Albrecht (CDU) who decided on the site in Gorleben in 1977. Reasons for the choice were political and economic, especially the closeness to the East German border and the low population density in the area (Endlager Gorleben 2009). Soon public protest arose against the plans. In 1979 a convoy of 500 tractors went to Hanover, and on 31 March that year the biggest demonstration in the history of Lower Saxony took place with 100,000 people present. Afterwards, Minister President Albrecht declared the plans as not feasible, which ended them (Jaschick 2010). In parallel, test drillings for the repository were carried out and were also accompanied by strong protests and a hut village was erected called the micronation "Republik Freies Wendland" (Free Republic of Wendland). (Figure 6) The hut village was evacuated in the same year by police forces. Protests against the repository plans have continued ever since and have been carried out granted by action groups like Bürgerinitiative Umweltschutz Lüchow-Dannenberg (Citizens' Initiative for Environmental Protection Lüchow-Dannenberg) or Bäuerliche Notgemeinschaft (Farmers' Emergency Association).

2 The site for an interim storage unit for dry cask storage was built between 1981 and 1983 in the face of massive protests and collisions with police. Protesters suffered from fractured ribs, insured kidneys, fractured heads, and blinded eyes that were caused by water guns (Geisler 2010). Opponents of the transports were systematically spied on by police and the Federal Agency for State Protection and Counter Terrorism (Verfassungsschutz 2001). Because of litigations and massive protests, the plant only started operating in 1995 with the first so-called Castor (cask for storage and transport of radioactive material) transport. Two casks filled with spent fuel from various German reactor sites and high-level nuclear waste from reprocessing facilities in France where shipped to the interim storage facility in Gorleben. The second transport was shipped in 1996 with one cask from the reprocessing plant in La Hague and a third transport a year later, in 1997, included

six casks. The fuel elements and vitrified waste block containers are in dry casks standing in a hall above ground and cooled by the surrounding air. They will stay in the casks for decades until they have cooled down from 400 °C to 200 °C and an appropriate repository has been found. Within these first three years the number of protesters increased from 4,000 to 10,000; police numbers increased to three times as much (from 7,600 to 30,000). As of 2011, 113 casks had been shipped to Gorleben. The Castor transports often become large events and receive remarkable national media coverage for several days in a row.

Figure 7 Gorleben protest: Conflicts between police and protesters

3 In Gorleben there is also a “pilot conditioning plant” where tests are made to condition the fuel elements in order to store them in a deep repository, and also to reload the containers for the vitrified waste blocks into containers suited to long-term storage. For technical reasons the dry cask storage containers are not suitable for long-term storage and cannot be placed in the salt dome.

Evaluation of engagement events: Like the anti-nuclear protests in the decades before, the clashes between opponents and police became extremely violent. The government’s handling of it was perceived as inappropriate by the anti-nuclear movement and the broader public alike (Glaser 2012, 16, Narr 1997, Hintergrund 2010).

Relevant documents: Media articles e.g., Der Spiegel (Gorleben 1982), Gorleben archive (also accessible online, e.g., for Gorleben chronicle), online archive and active archive on documents for Bürgerinitiative Umweltschutz Lüchow-Dannenberg, archive of the Rechtshilfe Gorleben, Gartow, Archive of the State Parliament of Lower Saxony; (Figure 7) Federal Archive in Koblenz, archive of the research mine Asse, Remlingen, Castor transport reports (Narr 1997).

Energy transition after Fukushima

Who was involved: Professional associations (e.g., the German Atomic Forum) and the Federal Government (Social Democratic Party and the Greens, later also the Christian Democratic Party), Germany’s Ethics Commission on Safe Energy Supply, energy companies.

When and where did it take place: In the years 1998–2011 on the government level.

What type of process was it – changes over time: Communication process.

In the year 1998 the red-green coalition decided to phase out nuclear energy within 20 years (Munsberg 1998). In 2000 an agreement about the future operation of German nuclear power plants between the Federal Government and electricity supply companies was signed (Informationskreis Kernenergie 2015). After the tsunami and partial meltdown at Fukushima Daiichi in 2011, the topic received renewed societal attention. Chancellor Angela Merkel announced that all German power plants would be closed down by 2022 with eight of the 17 operating German reactors being shut down immediately (Germany 2011). There have always been strong links between the government and professional associations based on collaboration that goes back decades. When the German government decided to phase out nuclear reactors, lobbyists such as the German Atomic Forum and the Nuclear Society tried to counteract the so-called Energiewende (energy transition).

Since then, even the German Atomic Forum has made its peace with the goals of the German energy transition and has begun to focus its activities on keeping up engineering competence in dismantling nuclear reactors and radioactive waste storage (Interview Güldner). Energy companies like Areva changed their policy to focus on export and scientific research instead of processing fuel elements (Interview Schuch and Meyer zu Schwabedissen).

Evaluation of engagement events: The evaluations of the event vary in Germany and Europe. German society, politicians, and historians interpret the controversy over nuclear energy, including the phase-out, predominantly as a success story (Radkau 1987; Weitze and Trischler 2006) and regard the process as deeply democratic. In contrast, many other countries and academic colleagues are critical of the violence of the debates and protests (Hughes 2014) and consider the phase-out decision as "a misguided and potentially damaging interpretation of the precautionary principle" (Moore 2012, no page numbers). This shows that nuclear energy and society's perception and interpretation of the developments vary considerably from country to country.

Relevant documents: Interviews with Matthias Schuch and Christian Meyer zu Schwabedissen from the German subsidiary of the French energy company Areva, and Ralf Güldner, President of the German Atomic Forum, documents from the Federal Archive, newspaper articles e.g., in *Der Spiegel, TAZ, Die Zeit,* agreement between the Federal Government of Germany and the energy supply companies, numerous media reports, archives of energy companies e.g., PreußenElektra, Hanover, Green Memory Archive, Berlin, Archive of Social Democracy (archive for documents on the SPD), Bonn, Archive for Christian-Democratic Policy (CDU), Sankt Augustin.

Facts & Figures

The purpose of this section is to give an overview of nuclear power in Germany. This section contains such data as the number of reactors, reactors' locations, technical and chronological details of reactors' construction, as well as statistics on electricity production, periodization, and social connections to nuclear construction.

Data summary

- Germany shut down most of its reactors following the Fukushima accident in 2011.
- Previously, Germany had 17 operating reactors, which provided 25 percent of electricity in the country.
- Public opinion about nuclear power in Germany is negative.

Key dates and abbreviations

Key dates

1955 After the Federal Republic of Germany gets its sovereignty, Chancellor Konrad Adenauer and the Federal Government establish the Federal Ministry for Atomic Issues (16 October 1955), and Franz Josef Strauß becomes Minister for Atomic Affairs.

1956 Nuclear research centers in Berlin, Hamburg, Geesthacht, Jülich, and Karlsruhe.

1957 Establishment of the European Atomic Energy Community (EURATOM) in March and founding of the International Atomic Energy Agency at the end of July.

1957 The first nuclear reactor in Germany, called "Nuclear Egg" starts operations at the end of October. It is a research reactor at the Technical University of Munich.

1958 Establishment of the Reactor Safety Commission (Reaktor-Sicherheitskommission – RSK).

1959 Establishment of the German Atomic Forum (Deutsches Atomforum) – a platform to connect business, science, and industry for promotion of peaceful nuclear energy.

1959 The Atomic Energy Act is announced in Germany, which makes construction and operations of NPP legal.

1960 Start of Fast Breeder Reactor (FBR) project in Karlsruhe, Baden-Wuerttemberg.

1960 The Atomic Energy Act comes into force in January and the first Radiation Protection Ordinance comes into force in September.

1961 In March, the Karlsruhe Nuclear Research Center puts FR-2 into operation, a heavy-water reactor and the first German-built reactor.

1961 First time electricity from a test nuclear reactor is generated for the national grid by research NPP (Versuchsatomkraftwerk, VAK) in Kahl, Bavaria.

1967	Experimental nuclear waste storage in the Asse salt mine in the West German state of Lower Saxony.
1969	Establishment of the German Nuclear Society (Kerntechnische Gesellschaft).
1973	Announcement of Wyhl, Baden-Wuerttemberg, as site for a nuclear power plant and first strong protests against it.
1974	Construction of first 1,200 MWe reactor in the world begins in Germany, Hesse, at Biblis NPP.
1976	Anti-nuclear demonstrations in Brokdorf in the West German state Schleswig-Holstein in the north of Germany.
1977	The first German-made FBR reactor is put into operation at the Karlsruhe Nuclear Research Center in Baden-Wuerttemberg in the south of Germany.
1977	Anti-nuclear demonstrations in Kalkar in the West German state of North Rhine-Westphalia.
1981	Mass anti-nuclear demonstration in Brokdorf becomes violent.
1982	Beginning of foundation construction for Germany's first large uranium enrichment plant in Gronau, Westfalia.
1986	Massive anti-nuclear demonstration against the construction of the Wackersdorf reprocessing plant in Bavaria in response to the Chernobyl disaster.
1986	Founding of the Federal Ministry for the Environment, Nature Conservation, and Reactor Safety (BMU).
1986	Decision to phase out nuclear energy in Germany within ten years at the SPD party conference.
1986	The Brokdorf NPP is put into operation.
1990	German reunification and shutdown of nuclear power reactors in East Germany.
1998	Federal elections and formation of the coalition government, which decides to phase out nuclear energy as a future policy.
2009	New government cancels the phasing out of nuclear energy.
2010	The coalition government decides to give life extensions to NPPs.
2011	After the Fukushima disaster, parliament decides to speed up phasing out of nuclear power. Phase-out policy is reintroduced in Germany and eight reactors are shut down immediately after Fukushima.

Abbreviations

AEG	Allgemeine Elektricitätsgesellschaft
ANP	Advanced Nuclear Power
BBR	Joint venture of Brown, Boveri & Cie. (UK) and Babcock & Wilcox (USA), now ABB
BBC	Electric Company = Brown Boveri Electric Company
BBK	Brown Boveri-Krupp Reaktorbau GmbH
BNFL	British Nuclear Fuels Limited; renamed Westinghouse
BWR	Boiling Water Reactor (SWR 1000)
EPR	European Pressurized Water Reactor
EVU	Energieversorgungsunternehmen (energy supply enterprise)
ERAM	Endlager für radioaktive Abfälle (nuclear waste repository)
EURATOM	Europäische Atombehörde (nuclear agency)
FBR	Fast Breeder Reactor
GE/AEG	General Electric/ Allgemeine Electricitäts-Gesellschaft
HRB	Hochtemperatur Reaktorbau GmbH
IAEA	International Atomic Energy Agency
KWU	Kraftwerk Union
MWe	Megawatt electrical
NPP	Nuclear Power Plant
OECD/ NEA	Organization for Economic Cooperation and Development/ Nuclear Energy Agency
PWK	Projektgesellschaft Wiederaufarbeitung von Kernbrennstoffen mbH (Society for reprocessing of nuclear fuel)
PWR	Pressurized Water Reactor
RSK	Reaktor-Sicherheitskommission (Reactor Security Commission)
SNR	Schneller Natriumgekühlter Reaktor
SWR	Siedewasserreaktor (Boiling Water Reactor)
THTR	Thorium-Hochtemperaturreaktor (Thorium High-Temperature Reactor)
VAK	Versuchsatomkraftwerk (Experimental Atomic Power Plant)
WAK	Wiederaufarbeitungsanlage (Reprocessing Plant)

Map of nuclear power plants

Map 1 represents a map of nuclear power sites in Germany

Map 1: Nuclear power plants in Germany

Currently, there are no operating power plants in East Germany because of the type of reactors built in the German Democratic Republic.

Source: public domain

A List of reactors and technical and chronological details

The tables below show the list of reactors, suppliers, operators, and dates.

Table 1: Operational commercial nuclear power reactors. Sources: IAEA 2019, WNA 2016

No.	Name	Operator	Type	MWe net	Construction date	Grid power	Planned shutdown 2001	Agreed shutdown 2010	March 2011 shutdown & May 2011 closure plan
1	Biblis A	RWE	PWR	1167	1970	1975	2008	2016	Shutdown
2	Biblis B	RWE	PWR	1240	1972	1977	2011	2018	Shutdown
3	Brokdorf	E.ON	PWR	1370	1976	1986	2019	2033	2021
4	Brunsbüttel	Vattenfall	BWR	771	1970	1977	2009	2018	Shutdown
5	Emsland	RWE	PWR	1329	1982	1988	2021	2035	2022
6	Grafenrheinfeld	E.ON	PWR	1275	1975	1982	2014	2028	Shutdown 2015
7	Grohnde	E.ON	PWR	1360	1976	1985	2017	2031	2021
8	Gundremmingen B	RWE	BWR	1284	1976	1984	2016	2030	End 2017
9	Gundremmingen C	RWE	BWR	1288	1976	1985	2016	2030	2021
10	Isar-1	E.ON	BWR	878	1972	1979	2011	2019	Shutdown
11	Isar-2	E.ON	PWR	1400	1982	1988	2020	2034	2022
12	Krümmel	Vattenfall	BWR	1260	1974	1984	2016	2030	Shutdown
13	Neckarwestheim-1	EnBW	PWR	785	1972	1976	2009	2017	Shutdown
14	Neckarwestheim-2	EnBW	PWR	1305	1982	1989	2022	2036	2022
15	Philippsburg-1	EnBW	BWR	890	1970	1980	2012	2026	Shutdown
16	Philippsburg-2	EnBW	PWR	1392	1977	1985	2018	2032	2019
17	Unterweser	E.ON	PWR	1345	1972	1979	2012	2020	Shutdown

Before the Fukushima disaster, Germany planned to shut down its reactors as they reach over 30 years of operation. In 2010, the shutdown timetable was agreed upon as presented in Table 1. However, after Fukushima, eight reactors were shut down immediately and the scheduled shutdown time for other reactors was significantly reduced.

Table 2: Reactors in Germany shut down before Fukushima. Sources: IAEA 2019, WNA 2016

No.	Name	Operator	Type	MWe net	Construction date	Grid power	Shutdown	Status
1	AVR Jülich	AVR	HTGR	13	1961	1967	1988	
2	Greifswald-1	EWN	WWER-440/213	408	1970	1973	1990	Dismantled
3	Greifswald-2	EWN	WWER-440/213	408	1970	1974	1990	
4	Greifswald-3	EWN	WWER-440/213	408	1972	1977	1990	
5	Greifswald-4	EWN	WWER-440/213	408	1972	1979	1990	
6	Greifswald-5	EWN	WWER-440/213	408	1977	1989	1989	Dismantled
7	Großwelzheim	HDR	BWR	25	1965	1969	1971	Dismantled
8	Gundremmingen A	KRB	BWR	237	1962	1966	1977	Dismantled
9	Kahl		BWR	15	1958	1961	1985	Site unrestricted
10	Kalkar KNK-2	KfK	FBR	17	1974	1978	1991	
11	Karlsruhe MZFR	KBG	PHWR	52	1961	1966	1984	
12	Lingen	RWE	BWR	183	1964	1968	1979	Safestor
13	Mülheim-Kärlich	SCN	PWR	1219	1975	1986	1988	
14	Niederaichbach	KfK	HWGCR	100	1966	1973	1974	Site unrestricted
15	Obrigheim	EnBW	PWR	340	1965	1968	2005	
16	Rheinsberg	EWN	WWER-210	62	1960	1966	1990	Dismantled
17	Stade	E.ON	PWR	640	1967	1972	2003	
18	THTR	HKG	HTGR	296	1971	1985	1988	Safestor
19	Würgassen	Preußen Elektra	BWR	640	1968	1971	1994	

B Data on electricity production, nuclear development and companies

Share of electricity in 2013: gas declined 21 percent from 2012, and coal share rose before declining in 2014.

In the first half of 2014: gas-fired input dropped a further 14 percent to 16.6 terawatt-hours/TWh, lignite provided 69.7 TWh, hard coal 51.9 TWh, nuclear 45.0 TWh, wind 26.7 TWh, solar 18.3 TWh, biomass 25.6 TWh, and hydro 10.5 TWh. Total for six months: 264.3 TWh, of which 16.1 TWh was exported.

Germany's electricity production in 2014 (preliminary International Energy Agency figures): 615 TWh gross. In 2014 coal provided 275 TWh (more than half being lignite), nuclear 97 TWh, gas 61 TWh, biofuels and waste 57 TWh, wind 56 TWh, solar 35 TWh, and hydro 25 TWh.

Electricity exports: about 34 TWh, compared with 20 TWh in 2012.

Imports: gas, coal, and oil worldwide. Apart from lignite and renewables, Germany has only a few domestic resources. In 2011, Russia provided almost 40 percent of gas, followed by Norway, the Netherlands, and UK, while 14 percent was produced domestically.

Annual consumption: about 6400 kWh per capita. Gross consumption was 576 TWh in 2014.

Generating capacity in April 2014: 169.6 gigawatt electrical/GWe.

GWe comprising: 12.1 GWe nuclear, 5.6 GWe hydro, 33.7 GWe wind (0.6 offshore), 36.9 GWe solar, 28.2 GWe gas, 21.2 GWe lignite, 26.3 GWe hard coal, and 5.6 GWe biomass (Fraunhofer Institute). In the first half of 2014 wind and solar PV had capacity factors of 18 percent and 11 percent respectively, compared with 85 percent for nuclear.

C Nuclear development

Until 2010, the 17 nuclear units totalled 20,339 MWe. The last came into commercial operation in 1989. Six units were boiling water reactors (BWR) and eleven were pressurized water reactors (PWR). All were built by Siemens-KWU. A further PWR had not operated since 1988 because of a licensing dispute. This picture changed in 2011, with the operating fleet being reduced to nine reactors with 12,003 MWe capacity, and then to eight reactors with 10,728 MWe. In 2000, two of Germany's biggest utilities, VEBA and VIAG, formed E.ON, which owned or had a stake in 12 of the country's 19 nuclear reactors, which were operating then. From January 2016, E.ON spun off Uniper, which will take over E.ON's global energy trading and power generation in and outside of Europe. E.ON will continue operating and slowly close down its nuclear generating capacity in Germany.

D Equities of utility companies operating in Germany

E.ON has equity in the following nuclear plants (January 2016), which will be managed by its subsidiary PreußenElektra: Isar-1 100 percent, Unterweser 100 percent, Krümmel 50 percent, Brunsbüttel 33.3 percent (all shut down), Grafenrheinfeld 100 percent, Gundremmingen B and C 25 percent, Grohnde 83.3 percent, Brokdorf 80 percent, Isar-2 75 percent, Emsland 12.5 percent.

RWE has equity in the following nuclear plants: Gundremmingen 75 percent, Biblis 100 percent, Emsland 87.5 percent.

Vattenfall has equity in the following German nuclear plants: Brunsbüttel 66.7 percent, Krümmel 50 percent, Brokdorf 20 percent. It has written off SEK 10.2 billion (euros 1.2 billion) on Brunsbüttel and Krümmel. Also in Sweden: Ringhals 70 percent, Forsmark 66 percent.

EnBW has equity in the following nuclear plants: Neckarwestheim 100 percent, Philippsburg 100 percent.

References

Primary Sources

Unpublished Primary Sources

Green Memory Archive, Petra Kelly Archive, file no 480:

- "Women should push against U-export." 1984. *Tasmanien*, 28 May.

Deutsches Museum Archives:

- *Papers of Heinz Maier-Leibnitz*, NL111.

Federal Archive, Koblenz:

- *Deutsches Atomprogramm* (German Atomic Program), Bundeskanzleramt, B 136/6108, vol. 1–3.

Private archive of Karin Wurzbacher

- 1988. *Einwendungen gegen das geplante Vorhaben der DWK in Wackersdorf.* 21 July, transcript.
- Blomeyer, Cornelia, and Karin Wurzbacher. 2016. *Statements about appeal in Neundorf against the reprocessing plant in Wackersdorf given by the two activists.*

Published Primary Sources

Atomic Energy Act on the peaceful utilization of atomic energy and the protection against its hazards. Act of 23 December 1959; Bundesgesetzblatt (BGBl), I 1959, 814. Accessed 11 November 2016. http://www.bgbl.de/xaver/bgbl/start.xav?startbk=Bundesanzeiger_BGBl&jumpTo=bgbl159s0814.pdf.

Bauriedel, Thea. 1988. "Kampf um Wackersdorf I + II." In *Anmerkungen aus dem Institut für Politische Psychoanalyse München*, 2. Vol. Munich: Self-published.

Bethe, Hans Albrecht, and J. H. Tait. 1956. "An Estimate of the Order of Magnitude of the Vigorous Interaction Expected Should the Core of a Fast Reactor Collapse". *UKAEA RHM* 56:113. Accessed 14 June 2016. http://fissilematerials.org/library/bet56.pdf,

Government's reply to the minor interpellation submitted by Sylvia Kotting-Uhl, Annalena Baerbock, Bärbel Höhn, and further members of the Bundestag and fraction Bündnis 90/Greens. Printed papers 18/668, Deutscher Bundestag – 18th legislative period, 26 February 2014. Accessed 24 May 2016. http://dipbt.bundestag.de/dip21/btd/18/006/1800668.pdf.

Mütter gegen Atomkraft, ed. [1988]. *Reden gegen die WAA. Einwendungen der Mütter gegen Atomkraft anlässlich des Erörterungstermins zur 2. atomrechtlichen Teilgenehmigung der WAA am 21. Juli 1988 in der Stadthalle von Neuburg vorm Wald.* Gilching: Oliver Kübrich.

Quistorp, Eva. 1979. "Frauen und Mütter gegen Naturzerstörung." In *Frauen und Mütter. Beiträge zur 3. Sommeruniversität von und für Frauen – 1978*, ed. by Sommeruniversität für Frauen. Berlin: Frauenbuchvertrieb.

Schlussbericht des Untersuchungsausschusses *"Wiederaufbereitungsanlage Wackersdorf".* Drucksache 10/10914, Bayerischer Landtag – 10. Legislaturperiode, 1.7.1986 *(Final report "Reprocessing Plant Wackersdorf" by the committee of inquiry of the Bavarian state parliament.* Printed papers, 10/10914, Bayerischer Landtag – 10th legislative period, 1 July 1986). Accessed 12 July 2016. https://www.bayern.landtag.de/fileadmin/www/ElanTextAblage_WP10/Drucksachen/0000010500/10-10914.pdf.

Secondary Literature

von Appen, Kai. 2011. "Gewerkschaften und Anti-Atom-Bewegung." *Robin Wood*, no 109 (2):35–36. Accessed 18 January 2017. http://www.dirkseifert.net/html/img/pool/gewerk-atom.pdf.

Bretschneider, Frank. 2011. "Kalkar. Milliardenschwere Investitionsruine statt 'Höllenfeuer'." *Rheinische Post online*, 15 March. Accessed 14 December 2016.

Carson, Cathryn. 2002. "Nuclear energy development in postwar West Germany. Struggles over cooperation in the Federal Republic's first reactor station." *History and Technology* 18 (3):233–270.

——. 2010. *Heisenberg in the Atomic Age: Science and the Public Sphere.* Cambridge: Cambridge University Press.

Cioc, Mark. 1988. *Pax Atomica: The Nuclear Defense Debate in West Germany during the Adenauer Era.* New York, London: Columbia University Press.

Eckert, Michael. 1990. "Primacy Doomed to Failure: Heisenberg's Role as Scientific Advisor for Nuclear Policy in the FRG." *Historical Studies in the Physical and Biological Sciences* 21:29–58.

Engels, Jens Ivo 2003. "Geschichte und Heimat. Der Widerstand gegen das Kernkraftwerk Wyhl." In *Wahrnehmung, Bewusstsein, Identifikation: Umweltprobleme und Umweltschutz als Triebfedern regionaler Entwicklung,* ed. by Kerstin Kretschmer, 103–130. Freiberg: Technische Universität Bergakademie.

——. 2006. *Naturpolitik in der Bundesrepublik. Ideenwelt und politische Verhaltensstile in Naturschutz und Umweltbewegung 1950–1980.* Paderborn: Ferdinand Schöningh.

Flaake, Karin. 2005. "Carol Gilligan. Die andere Stimme." In *Schlüsselwerke der Geschlechterforschung,* ed. by Martina Löw and Bettina Mathes, 158–175. Wiesbaden: Springer Verlag für Sozialwissenschaften.

Geisler, Astrid. 2010. "Auge um Auge. Die Verletzungsgefahr durch Wasserwerfer ist enorm hoch. Das ist den Behörden auch seit Jahrzehnten bekannt. Doch gelernt haben sie nichts, wie der Fall Dietrich Wagner beweist." *Tageszeitung,* 22 November. Accessed 19 July 2016. http://www.taz.de/Wasserwerfer-Einsatz-der-Polizei/!5131905/.

Glaser, Alexander. 2012. "From Brokdorf to Fukushima: The Long Journey to Nuclear Phase-Out." *Bulletin of the Atomic Scientists* 68 (November/December, no 6):10–21.

Gleitsman, Rolf-Jürgen. 1987. "Die Anfänge der Atomenergienutzung in der Bundesrepublik Deutschland." In *Das Ende des Atomzeitalters? Eine sachlich-kritische Dokumentation,* ed. by Armin Herrman and Rolf Schumacher. Munich: Moos Verlag.

Gleitsman, Rolf-Jürgen. 1988. *Im Widerstreit der Meinungen: Zur Kontroverse um die Standortfindung für eine deutsche Reaktorstation (1950–1955): Ein Beitrag zur Gründungsgeschichte des Kernforschungszentrums Karlsruhe und zu einem Kapitel deutscher Kernenergiegeschichte.* Karlsruhe: Kernforschungszentrum.

"Gorleben Chronik." In *Gorleben Archive.* Accessed 18 July 2016. http://gorleben-archiv.de/wordpress/chronik/.

Hanel, Tilmann. 2015. *Die Bombe als Option. Motive für den Aufbau einer atomtechnischen Infrastruktur in der Bundesrepublik bis 1963.* Essen: Klartext.

Hughes, Michael, L. 2014. "Civil Disobedience in Transnational Perspective: American and West German Anti-Nuclear-Power Protesters, 1975–1982." *Historical Social Research* 39 (4):236–253.

Kelleher, Catherine McArdle. 1975. *Germany and the Politics of Nuclear Weapons.* New York, London: Columbia University Press.

Khoo, Su-Ming, and Henrike Rau. 2012. "Movements, Mobilities and the Politics of Hazardous Waste." In *Environmental Movement and Waste Infrastructure,* ed. by Christopher Rootes and Liam Leonhard. Abingdon, Oxon: Routledge.

Kirchhof, Astrid Mignon. 2011. "Contemporary Ideas in a Traditional Mind-Set: The Nature Conservation Movement in Post War West-Germany (1945–1960)." *Ecozon 2* (1):34–47.

——. 2013. "Frauen in der Antiatomkraftbewegung. Am Beispiel der Mütter gegen Atomkraft." In *Ariadne. Forum für Frauen- und Geschlechtergeschichte* 62:48–57.

——. 2015. "Finding Common Ground in the Transnational Peace Movements." *Australian Journal of Politics and History* 61 (3):432–449.

Kirchhof, Astrid Mignon, and Jan-Henrik Meyer. 2014. "Introduction: Global Protest against Nuclear Power. Transfer and Transnational Exchange in the 1970s and 1980s." *Historical Social Research* 39 (1):165–190.

Kirchhof, Astrid Mignon, and Chris McConville. 2015. "Introduction: Transcontinental and Transnational Links in Social Movements and Environmental Policies in the 20th Century." *Australian Journal of Politics and History* 61 (3):331–338.

Kohlrausch, Martin, and Helmuth Trischler. 2014. Building Europe on Expertise: *Innovators, Organizers, Networkers.* Hampshire, New York: Palgrave Macmillan.

Küntzel, Matthias. 1992. *Bonn und die Bombe: Deutsche Atomwaffenpolitik von Adenauer bis Brandt.* Frankfurt a.M.: Campus.

Lenz, Ilse, ed. 2010. *Die neue Frauenbewegung in Deutschland. Abschied vom kleinen Unterschied. Eine Quellensammlung.* Wiesbaden: Verlag für Sozialwissenschaften.

Lorenz, Robert. 2011. *Protest der Physiker. Die "Göttinger Erklärung"* von 1957. Bielefeld: Transcript.

Mende, Silke. 2011. *Nicht rechts, nicht links, sondern vorn. Eine Geschichte der Gründungsgrünen.* Munich: Oldenbourg.

Marth, Willy. 1992. *Der Schnelle Brüter SNR 300 im Auf und Ab seiner Geschichte*, Report KfK 4666. Kernforschungszentrum: Karlsruhe.

Milder, Stephen. 2014. "Between Grassroots Activism and Transnational Aspirations: Anti-Nuclear Protest from the Rhine Valley to the Bundestag, 1974–1983." *Historical Social Research* 39 (4): 191–211.

——. 2019. "From Anti-Nuke to Ökopax: 1970s Anti-Reactor Activism, and the Emergence of West Germany's Mass Movement for Peace." In *Nature and the Iron Curtain: Environmental Policy and Social Movements in Communist and Capitalist Countries 1945–1990*, ed. by Astrid Mignon Kirchhof and John McNeill, 87-101. Pittsburgh: University of Pittsburgh Press.

Moore, John. 2012. *How Much Precaution is Too Much? Evaluating Germany's Nuclear Phase-Out Decision in Light of the Events at Fukushima.* London School of Economics (LSE), Institute of Public Affairs. Accessed 12 June 2016. http://www.lse.ac.uk/IPA/images/Documents/PublicSphere/2013/4-germany-nuclear-phaseout-2012.pdf.

Müller, Wolfgang D. 1990. *Geschichte der Kernenergie in der Bundesrepublik Deutschland. Anfänge und Weichenstellungen*, vol. 1. Stuttgart: Schäffer Verlag.

——. 1996. *Geschichte der Kernenergie in der Bundesrepublik Deutschland. Auf dem Weg zum Erfolg*, vol. 2. Stuttgart: Schäffer Verlag.

Oetzel, Günther. 1996. *Forschungspolitik in der Bundesrepublik Deutschland. Entstehung und Entwicklung einer Institution der Großforschung am Modell des Kernforschungszentrums Karlsruhe (KfK)* 1956–1963. Frankfurt a. M.: Peter Lang.

Radkau, Joachim. 1983. *Aufstieg und Krise der deutschen Atomwirtschaft. Verdrängte Alternativen in der Kerntechnik und der Ursprung der nuklearen Kontroverse.* Reinbek, Hamburg: Rowohlt.

——. 1987. "Die Kernkraft-Kontroverse im Spiegel der Literatur. Phasen und Dimensionen einer neuen Aufklärung." In *Das Ende des Atomzeitalters. Eine sachlich-kritische Dokumentation*, ed. by Armin Herrmann and Rolf Schumacher, 307–334. Munich.

Renn, Ortwin. 1995. "Perzeption: 'Akzeptanz und Akzeptabilität der Kernenergie.'" In *Handbuch Kernenergie: Kompendium der Energiewirtschaft und Energiepolitik*, ed. by Hans Michaelis and Carsten Salander, 762–776. Frankfurt: VWEW Verlag.

Rudig, Wolfgang. 1990. *Anti-Nuclear Movements: A World Survey of Opposition to Nuclear Energy.* Harlow, Essex: Longman.

Rusinek, Bernd-A. 1996. *Das Forschungszentrum. Eine Geschichte der KFA Jülich von ihrer Gründung bis 1980.* Frankfurt a.M., New York: Campus.

——. 2003. "Wyhl." In *Deutsche Erinnerungsorte* vol. 2, ed. by Hagen Schulze and Etienne François Erinnerungsorte, 652–666. Munich: Beck.

Schardinger, Verena. 2012. *Wackersdorf als Erinnerungsort. Der Konflikt um die atomare Wiederaufarbeitungsanlage und die deutsche Umweltbewegung.* MA thesis, Ludwig Maximilian University, Munich.

Schirrmacher, Arne. 2007. "Physik und Politik in der frühen Bundesrepublik Deutschland. Max Born, Werner Heisenberg und Pascual Jordan als politische Grenzgänger." *Berichte zur Wissenschaftsgeschichte* 30:13–31.

Schüring, Michael. 2015. *"Bekennen gegen den Atomstaat." Die evangelischen Kirchen in der Bundesrepublik und die Konflikte um die Atomenergie 1970–1990.* Göttingen: Wallstein.

Stamm-Kuhlmann, Thomas. 1992. "Euratom, Enea und die nationale Kernenergiepolitik in Deutschland." *Berichte zur Wissenschafts-geschichte* 15:39–49.

Thiessen, Barbara. 2010. "Feminismus: Differenzen und Kontroversen." In *Handbuch Frauen- und Geschlechterforschung. Theorie, Methoden, Empirie,* ed. by Ruth Becker and Beate Kortendiek, 37–44. Wiesbaden: VS Verlag für Sozialwissenschaften.

Tiggemann, Anselm. 2010. *Die "Achillesferse" der Kernenergie in der Bundesrepublik Deutschland. Zur Kernenergiekontroverse und Geschichte der nuklearen Entsorgung von den Anfängen bis Gorleben 1955 bis 1985.* Lauf: Europaforum Verlag.

Tompkins, Andrew. 2016. "Grassroots Transnationalism(s): Franco-German Opposition to Nuclear Energy in the 1970s." *Contemporary European History* 25:117–142.

——. 2016. *Better Active than Radioactive! Anti-Nuclear Protest in 1970s France and West Germany.* Oxford: Oxford University Press.

Trischler, Helmuth. 2015. "Munich as a Science City and High-Tech Region 1920 to 1970." In *Munich and National Socialism. Catalogue of the Munich Documentation Centre for the History of National Socialism,* ed. by Winfried Nerdinger, 522–530. Munich: C. H. Beck.

Walker, Mark. 1989. *German National Socialism and the Quest for Nuclear Power 1939–1949.* Cambridge: Cambridge University Press.

Weitze, Marc-Denis, and Helmuth Trischler. 2006. *"Kontroversen zwischen Wissenschaft und Öffentlichkeit: Zum Stand der Diskus-sion." In Kontroversen als Schlüssel zur Wissenschaft? Wissenskulturen in sprachlicher Interaktion,* ed. by Wolf-Andreas Liebert and Marc-Denis Weitze, 57–80. Bielefeld: Transcript.

Digital Sources

AtomkraftwerkePlag – Rechercheplattform zur Atomenergie. Die Atomlobby Konzerne. Accessed 26 May 2016. http://de.atomkraftwerkeplag.wikia.com/wiki/Die_Konzerne.

AtomkraftwerkePlag – Rechercheplattform zur Atomenergie. Gewerkschaften und Atomkraft. Accessed 26 May 2016. http://de.atomkraftwerkeplag.wikia.com/wiki/Gewerkschaften_und_Atomkraft.

AtomkraftwerkePlag – Rechercheplattform zur Atomenergie. Die Atomlobby Subven-tionen. Accessed 26 May 2016. http://de.atomkraftwerkeplag.wikia.com/wiki/Subventionierung_von_Atomkraft.

BUND, Regionalverband südlicher Oberrhein, ed. 2014. *Bauplatzbesetzung Marckolsheim Elsass 1974–1975: Ein wichtiger Impuls für die Umweltbewegung.* Accessed 18 July 2016. http://www.bund-rvso.de/europ-awahl-bauplatzbesetzung-marckolsheim.html.

BUND Naturschutz in Bayern e.V., ed. 2015. „Zeitzeugen im Naturschutz: Marianne Laepple – Widerstand gegen die WAA in Wackersdorf", documentary, 11 December. Accessed 12 July 2016. https://www.youtube.com/watch?v=GN_TICZgpAU.

„Endlager Gorleben aus Expertensicht nur zweite Wahl". Interview of the German Depeschendienst with the Geologist Gerd Lüttig, 7 August 2009. Accessed 19 July 2016. http://www.verivox.de/nachrichten/interview-endlager-gorleben-aus-experten-sicht-nur-zweite-wahl-43384.aspx.

IAEA Country Nuclear Power Profiles. Accessed 18 June 2019. https://cnpp.iaea.org/countryprofiles/Germany/Germany.htm.

Informationskreis Kernenergie. 2015. *Informationen zur friedlichen Nutzung der Kernenergie und Kerntechnik.* Accessed 12 April 2016. http://www.kernenergie.de/kernenergie/themen/geschichte.

Narr, Wolf-Dieter. 1997. "Der Castor-Transport 1997 – Demonstrationen und Polizei-einsätze." In *Bürgerrechte & Polizei/CILIP,* no 56, January. Accessed 24 May 2016. https://archiv.cilip.de/alt/ausgabe/56/castor.htm.

Schils, Nathalie. 2011. "Mass occupation of proposed Wyhl nuclear power plant site in Germany, 1974–1977". Global Nonviolent Action Database, 7 July. Accessed 23 April 2016. https://nvdatabase.swarthmore.edu/content/mass-occupation-proposed-wyhl-nuclear-power-plant-site-germany-1974-1977.

Wunderland Kalkar webpage. Accessed 15 June 2016. https://www.wunderland-kalkar.eu/en/themepark/attractions.

World Nuclear Association. 2016. Nuclear Power in Germany. Accessed 24 May 2016. http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/germany.aspx.

Media

Newspapers

Der Spiegel, 1981, 1982, 1984, 1989, 1998.

Die Zeit, 1977.

Frankfurter Allgemeine Zeitung, 2011.

New York Times, 1986.

Rheinische Post, 2001.

"Germans Arrest 300 in Antinuclear Protests." 1986. *New York Times*, 9 June. Accessed 12 July 2016. http://www.nytimes.com/1986/06/09/world/around-the-world-germans-arrest-300-in-antinucle-ar-protests.html.

"Gorleben: 'Noch lange nicht zu Ende.' Die Aussicht auf Atom-Industrialisierung hat das Wendland entzweit." 1982. *Der Spiegel*, 11 January. Accessed 18 July 2016. http://www.spiegel.de/spiegel/print/d-14335069.html.

"Kalter Kaffee." 1984. *Der Spiegel*, No. 14, 2 April: 78–80. Accessed 17 January 2017. http://www.spiegel.de/spiegel/print/d-13507799.html.

Kühnert, Hanno. 1977. "Wyhl-Verhandlungen: Am runden Tisch. Der Prozeß über das Kraftwerk setzt neue Maßstäbe." *Die Zeit*, 4 February. Accessed 18 July 2016. http://www.zeit.de/1977/06/am-runden-tisch/komplettansicht.

Meyer-Larsen, Werner. 1981. "Der Koloß von Kalkar." *Der Spiegel*, no 43, 19 October: 42–55. Accessed 11 November 2016. http://www.spiegel.de/spiegel/print/d-14338834.html.

Mrusek, Konrad. 2011. "Der erste Aussteiger. Klaus Traube im Porträt." *Frankfurter Allgemeine Zeitung*, 21 March. Accessed 15 January 2017. http://www.faz.net/aktuell/politik/energiepolitik/klaus-traube-im-portraet-der-erste-aussteiger-1610402.html?printPagedArticle=true#pageIndex_2.

Munsberg, Hendrik. 1998. "Abschied vom Atomstrom." *Der Spiegel* 52:22–26.

"Verfassungsschutz spionierte Atomkraftgegner aus." 2001. *Rheinische Post online*, 28 February. Accessed 19 July 2016. http://www.rp-online.de/politik/verfassungsschutz-spionierte-atomkraftgegner-aus-aid-1.2270930.

Walraff, Rudolf, and Dieter Kampe. 1989. "'Es lag jenseits unserer Vorstellungskraft.' SPIEGEL-Gespräch mit VEBA-Chef Rudolf von Bennigsen-Foerder über das mögliche Ende der WAA Wackersdorf." *Der Spiegel*, no 16, 17 April: 28–31. Accessed 12 July 2016. http://www.spiegel.de/spiegel/print/d-13494469.html.

"Wenn Gras über die Atomkraft wächst." 2011. *Frankfurter Allgemeine Zeitung*, 17 March. Accessed 16 December 2016. http://www.faz.net/aktuell/rhein-main/region/karlstein-wenn-gras-ueber-das-atomkraftwerk-waechst-1607829.html.

Documentaries/Broadcastings

"Germany: Nuclear power plant to close by 2022." 2011. *BBC*, 30 May. Accessed 14 April 2016. http://www.bbc.com/news/world-europe-13592208.

"Hintergrund: Atommüll-Zwischenlager Gorleben." 2010. *NDR*, 23 March. Accessed 24 May 2016. https://web.archive.org/web/20100911235711/http://www.ndr.de/regional/dossiers/atomkraft/hintergrund/castor6.html.

Hubert, Antje. 2012. *Das Ding am Deich.* Documentary. Trailer available online. Accessed 23 April 2016. http://www.dingamdeich.de/filmecms/ding-trailer-2012-7.mp4.

Isenson, Nancy. 2009. "Nuclear Power in Germany: A Chronology." *Deutsche Welle*, 10 September. Accessed 12 April 2016. http://dw.com/p/9fyz.

Jaschik, Gisela. 2010. "März 1979: Gorleben-Treck nach Hannover." *Norddeutsche Geschichte.ndr.de*, broadcast, 14 December. Accessed 19 July 2016. http://www.ndr.de/kultur/geschichte/gdgm/geschichte274.html.

Knoll, Stefanie, and Kurt Keerl. 2006. Schreckgespenst WAA – Widerstand in Wackersdorf. Documentary, Medienwerkstatt. Accessed 11 November 2016. https://vimeo.com/57662119.

Nabel, Imogen, and Lydia Egger. 2013. 40 Jahre AKW-Widerstand: Wyhl? "Nai hämmer gsait!". *SWR-Geschichtsdokumentationen*, 10 October. Accessed 18 July 2016. https://www.youtube.com/watch?v=4y-bq9MjL2fE.

Interviews

Manfred Popp, longstanding CEO of the Research Center Karlsruhe, 9 May 2016.

Marco Avena, activist "Robin Wood" and "Energiepolitischer Runder Tisch," 26 May 2016.

Ralf Güldner, President of the German Atomic Forum, 27 May 2016.

Matthias Schuch and Christian Meyer zu Schwabedissen, energy company Areva, 16 June 2016.

Reiner Szepan, physicist and independent expert, 12 December 2016.

Karin Wurzbacher, activist "Mothers Against Atomic Power", 24 May 2016.

Matteo Gerlini

The Rise and Fall of Nuclear Italy

Executive Summary

This chapter focuses on the history of the relations between nuclear energy and society in Italy. The main findings are that before the nationalization of electricity, there were large investments in the nuclear sector – among the biggest in the world – by the oligopoly concerned with power production and by the state; that there was a reduction fluctuation in the investment after nationalization, because of costs to the public utility of the expropriation of private companies; that an Italian prototype reactor was to be developed as a national power reactor; and that the political parties' ambivalence to support nuclear energy which led to Italy ceasing to use nuclear power.

Historical Context

Introduction

In Italy the history of nuclear energy started under the Fascist regime, continued during the Second Cold War (1979–1985) and the reconstruction era, and – following the changes that occurred during the long post war period – lasted until the Second Cold War. The pursuit of nuclear weaponry ceased when Italy acceded to the Non-Proliferation Treaty (NPT), signed on January 28, 1969, and ratified on May 2, 1975. Subsequently, support for electronuclear projects faded; after public debate on the matter, promoters and supporters of nuclear energy were revealed as being in the minority, as confirmed by the referendum that took place on November 8 and 9, 1987. The same position was reaffirmed in the 2011 referendum on the same subject.

The context within which Italian nuclear history takes place includes, at its early beginning, the school of nuclear scientists founded by Enrico Fermi, who strongly collided with Fascism after the promulgation of the racial laws in 1938. From the perspective of the world history of nuclear energy, these outstanding scientists as Ettore Majorana played a significant role in the application of the discoveries of nuclear physics and the debate that followed. In 1945, the war over, Italy experienced the deepest transformation in its history, marked by the end of the monarchy and the birth of the Republic, decided in the institutional referendum of June 2, 1946. The Italian economy was obviously at its lowest, and the political parties, the lifeblood of the new Republic, were faced with the paramount task of reconstructing the nation.

The key political choice for reconstruction concerned the international system within which the new republic was to find its position. The head of the government, the Christian Democrat Alcide De Gasperi, pursued a strategy of alignment with the Western bloc, which was opposed by the left and the neutralist components of his party. De Gasperi worked towards Italy's participation in the European Recovery Program (ERP), launched by the United States in 1947. In April 1948, the first election in the republic marked the victory of the Christian Democrats over the Socialists and Communists, thus speeding up the process of alignment, which culminated in the Republic of Italy joining the North Atlantic Treaty in 1949. The Christian Democrats remained the governing party during the whole of the period known as the First Republic, at first by itself, and later flanked by other parties in several coalitions.

From the perspective of the Western bloc, nuclear energy had the potential to play a role in the reconstruction of the country: those were the years when electronuclear production was considered a promising supplement to traditional energy provision. Investing in this sector mirrored the historical question of the lack of coal resources that had forced the Italian industry to turn to hydroelectric production instead of coal, which had to be purchased from abroad. Likewise, although the Ente Nazionale Idrocarburi (ENI, the National Hydrocarbons Authority) was carrying out a courageous policy vis à vis the oil producing countries, electronuclear production seemed to offer a higher degree of autonomy. In addition, for part of the armed forces and for the government, the military applications of nuclear energy were enticing but hard to reach. Technical limits, as well as problems linked to the reconstruction of the defense sector after the country's defeat, prevented Italy from acquiring nuclear weaponry. The Italian armed forces were completely rebuilt under the Atlantic Treaty, and they followed the government's lead in supporting the nonproliferation policy of the United States. This was also favoured by Italian nuclear scientists, a significant part of public opinion, and the left in particular.

Both Socialists and Communists would have favoured the development of the electronuclear program in Italy, although the general political and economic frame in Italy relied on the large electric companies that had first brought electricity to the country. Conversely, the right wing parties considered the Italian nuclear program as one of the items on the list of the country's energy requirements, without necessarily being more important than other industrial development projects. The Christian Democrats kept an open mind towards the question.

At first, the private sector, led by the main electric companies, fostered the development of electronuclear programs. Later, the public sector started to carve out a role for itself, as had happened in other countries that had started a nuclear program, in a process that became entangled with the debate over the nationalization of electric power. When Law no. 933 of August 11, 1960 created the body called the Comitato Nazionale Per L'Energia Nucleare (CNEN, National Committee for Nuclear Energy), which corresponded to the commissions for nuclear energy in the other countries in the Western bloc, Italy was on the verge of enacting a law nationalizing electric energy, which was approved in November 1962 by the first centre left government.

The life of the new nuclear body was very hard. To begin with, a scandal hit its management in 1964 when general secretary Felice Ippolito was arrested, and in subsequent years it never managed to play a role in top level decision making regarding the development of nuclear energy in Italy. Therefore, in the period 1963–68, when the centre left was in government with the participation of the Socialists, Italian nuclear programs could hardly be said to be connected to an underlying political strategy. This trend remained steady well beyond the seventies, continuing into the five party coalition government period, which began in 1981 with the further reduction of the influence of the Christian Democrats, who renounced the chairmanship of the Council of Ministers. Nevertheless, those were the years when the Italian nuclear system, despite its polymorphism, carried out significant improvements: for example, international cooperation in the field of breeder reactors.

When the conservation movements of the 1980s formed an alliance with the peace movements, marking the Euromissile crisis, a significant moment in the Second Cold War – public opinion in Italy was already shifting towards opposition to electronuclear development. The nuclear accident at Chernobyl cemented this, and when the following year a referendum on nuclear energy was held, the majority voted for the abrogation of the regulations that allowed the development of the sector. The government responded to this result by shutting down the whole electronuclear department, thus also influencing research in the nuclear field.

When the First Republic came to an uncertain end in the years 1992–94, the debate about whether or not it was worthwhile to go back to electronuclear production was not resumed until the fourth government chaired by Silvio Berlusconi, first president of Minister's Council of what is known as the Second Republic, reintroduced some elements of energy planning that aimed to reinstate the sector. A second referendum held on June 12–13, 2011, abrogated the government decrees, leaving the situation unaltered at the time of writing.

Contextual narrative

Origins of the applied nuclear sciences in Italy

The historical premises of civil nuclear programs in Italy may be traced back to the creation of nuclear physics in 1926, when the young, brilliant physicist Enrico Fermi was appointed as the first chair of theoretical physics at Sapienza University of Rome. A former student at the Scuola Normale in Pisa and a Freemason, Fermi brought together a group of brilliant researchers who made a crucial contribution to the foundation of nuclear physics. Although Fermi had been appointed as a member of the Royal Academy by Benito Mussolini, in 1938 the Fascist regime denied the funds required for the research. At the same time, the regime began promulgating racial laws, forcing Fermi to take a decision he had long been pondering: his wife Laura Capon was Jewish and the family chose to flee abroad to escape the impact of the laws. The opportunity to leave arose when the scientist was awarded the Nobel Prize in Physics in 1938: from Stockholm, where he received the award, they traveled to the United States and Fermi started working in American laboratories, developing the first nuclear pile, which made a pivotal contribution to the Manhattan project that would later create the nuclear bomb (Paoloni 2009, 14–22).

The news of the Hiroshima bombing stirred up the already lively debate in Italy on the use of the enormous energy released by nuclear fission. In Milan, on December 19, 1946, the private company Centro Informazioni Studi Esperienze (CISE, Centre for Information, Studies and Experience), was created by a group of technicians and scientists from the academia and from Italy's largest electric power company, Edison (Zaninelli 1996, passim). The engineer Vittorio De Biasi, managing director of Edison, had charged the young engineer Mario Silvestri with responsibility for the nuclear program, along with Giuseppe Bolla, professor of physics at the University of Milan, and his assistants Giorgio Salvini and Carlo Salvetti. They were supported by Edoardo Amaldi, who had been a student with Fermi; the latter had stayed in Italy during the war and was the main Italian nuclear physicist of the postwar period: he had successfully brought together the top Italian industrial groups such as the car manufacturer FIAT, the steel company Cogne, the chemical company Montecatini, and the Adriatic electric company

SADE as funders (Silvestri 1968, 42–67). Led by Bolla, they went to Paris, where the peace treaty with Italy was being negotiated, to obtain reassurances from Alcide De Gasperi regarding the absence of clauses that would deny Italy the opportunity to use nuclear energy for civil purposes. From 1946 to 1952, CISE advocated an autonomous three fold nuclear program for Italy. The first step would be the creation of a group of experts, the second the making of a zero power pile similar to the one Fermi had built in Chicago, and the third the building of a 10 MW heavy water national reactor, entirely designed in Italy, and powered by natural uranium (Paoloni 2009, 25).

In 1949, the mathematician and engineer Gustavo Colonnetti, president of the Consiglio Nazionale delle Ricerche (CNR, National Council for Research), wrote to De Gasperi asking for more resources to be allocated for nuclear physics research. Through Amaldi, Colonnetti secured Fermi's support and after the elections of April 18, the latter wrote to De Gasperi guaranteeing that the results of studying nuclear physics would be worth the investment (Battimelli 2003).

Also in 1949, the concerted pressure from nuclear physicists and the industrialists of CISE finally started affecting the government, who eventually planned an Italian centre for atomic studies, to be funded by the government and the relevant industrial groups, such as the arms manufacturer Terni, which suggested to CISE an agreement with the Ministry of Defense and the army to promote civil nuclear research. CISE was wary of the army becoming involved in electronuclear research and in March 1950 the minister of defence called on the minister of education, the minister of industry and commerce, and the minister of international commerce to create a commission that would deal with problems relevant to atomic energy. The initiative was not backed by Amaldi, who was acting together with the chemist Mario Alberto Rollier, advisor of the Minister of Industry; both were active supporters of the European Federalist Movement. But despite this clash between nuclear physicists and the army, the army and CISE were able to reach an agreement with CISE in October 1950. Nevertheless, the army's plans were subject to the evolution of NATO, which Italy had signed in 1949 (Nuti 2007, 53–70).

At the end of 1951, CISE had reached a significant milestone, realizing a pilot plant for the production of heavy water by electrolysis, and an experimental plant for uranium metallurgy. Its researchers, working in laboratories equipped with state of the art electronic instruments, had taken significant steps towards uranium fission, but more significant was the progress made in training qualified personnel: the CISE laboratories trained the experts who would play a central role in Italian research in the nuclear field in later years (Zaninelli 1996, 43–88). The year 1951 also saw important milestones: the funds Colonnetti had requested in 1948 were granted; the budget allocated for the CNR was doubled; most of the resources were invested in basic nuclear physics research; and the INFN, a national institute for nuclear physics, was created, which was tasked with coordinating the CNR branches dealing with nuclear research (Battimelli, De Maria, Paoloni 2001, passim).

On June 26, 1952, a decree constituting the Comitato nazionale ricerche nucleari (CNRN, the National Committee for Nuclear Research) was passed, and the state became a player in nuclear matters. The body had no legal personality of its own; its role was as an advisory body to the CNR, although it was not subject to it, falling instead under the authority of the Ministry of Industry. The board included: Francesco Giordani, President of CNRN and professor of electrochemistry at the University of Naples; the General Secretary Felice Ippolito, professor of applied geology in the same university; and Amaldi, a member of the committee (Curli 2000, 32–34). Most of the literature on this topic acknowledges the conflict between CISE and CNRN, which ultimately resolved in favour of the state committee in 1955, when a public finance company formed by the Istituto per la Ricostruzione Industriale (IRI, Institute for Industrial Reconstruction) and the Municipality of Milan, acquired 50% of the shares in it. From 1939 to 1943, Giordani had chaired the IRI, the public body responsible for industrial reconstruction under the Fascist regime, and later the prime subject of state economic intervention in the years of the First Republic (Castronovo 2012, passim).

In Paris, in July 1953, an Italian delegation participated in a meeting with representatives of other European countries to discuss the common interest in creating a European nuclear body, under the name European Atomic Energy Community (Euratom). In its involvement in this emerging process of European integration, CNRN started favouring the acquisition of US technology, due to the new attitude the US was showing towards access to information relevant to the civil use of nuclear energy. The change was signaled in a speech the President of the United States, Dwight D. Eisenhower, gave at the UN on December 8, 1953, where he introduced the Atoms for Peace program, creating a market for the nuclear industry in which the US firms had a prominent role. In 1955 CNRN supported a cooperation agreement between the US and Italy that would include the following: 1) Italy would buy a supply of heavy water; 2) Italy would also buy its first power reactor as a pilot plant; 3) with knowhow of the pilot plant, Italy would build industrial scale plants. The nuclear power produced Kw would be affordable because the power costs were very expensive in the Italian market. The Italian economy suffered the lack of resources for the production of electric power. CISE researchers felt that with this choice, CNRN was giving up on the development of the national reactor, although CNRN's strategy was in fact the same as that pursued by the other nations defeated in WWII, namely Germany and Japan, who entered into similar agreements with the United States. We must read the choice made by CNRN within the context of 1955, marked by the major UN conference on atomic energy in Geneva, when the Soviet Union was the only nation with a working nuclear power reactor. At the time, it was acceptable for a country with the industrial structure that Italy had to want to seize the opportunity offered by the world's other superpower. Nevertheless, the United States did not consider it appropriate to sell a reactor similar to the one they had at the times under construction in Rowe, Massachusetts, to a nation that did not possess a running experimental reactor (Paoloni 1992, 5–43).

While the negotiations were still under way in December 1955, Edison created the Società Elettronucleare Italiana (SELNI, Italian Electronuclear Society) with other public and private companies and manufacturing companies from the centre and north of Italy, with the aim of building their own power reactor. Again, this initiative, started by the largest private power company, turned to the US market, evaluating the offers made the following year by Westinghouse and General Electric. Those months were critical for supporters of nuclear power in Italy: In April 1956, the public companies owned by Finelettrica and controlled by IRI left SELNI; from the end of 1955 to July 1956, CNRN negotiated with CISE for the installation and the running of a research reactor, purchased from the American Machine and Foundry company and similar to the CP 5 of the Argonne National Laboratory, which was to be built in Ispra, on the shores of Lake Maggiore. Once the contracts had been approved, Giordani resigned as chair of CNRN: the committee had suffered severe losses and was a focal point of clashes between those who wanted to strengthen it, and those who wanted to downscale it, as it was a significant player in the debate over the nationalization of electric power, which was unrelenting in those years. Ippolito was charged for some alleged illicit administrative acts, while waiting for the government's decision on the nature of NRN, which came on August 14, 1956 (Curli 2000, 43–44). CNRN became an organization with its own autonomous headquarters and hired personnel, chaired by Basilio Focaccia, professor of electro technology at the University of Rome. Italy would accept all the safeguard clauses stipulated by the USA, as the International Agency of Atomic Energy (IAEA) did not have its own at the time. Very active in Europe as well, the Italians invested quite some energy in the creation of Euratom, whose founding treaty was developed at a technical conference in Venice in May 1956 and signed in Rome in March 1956, together with the treaty that created the European Economic Community.

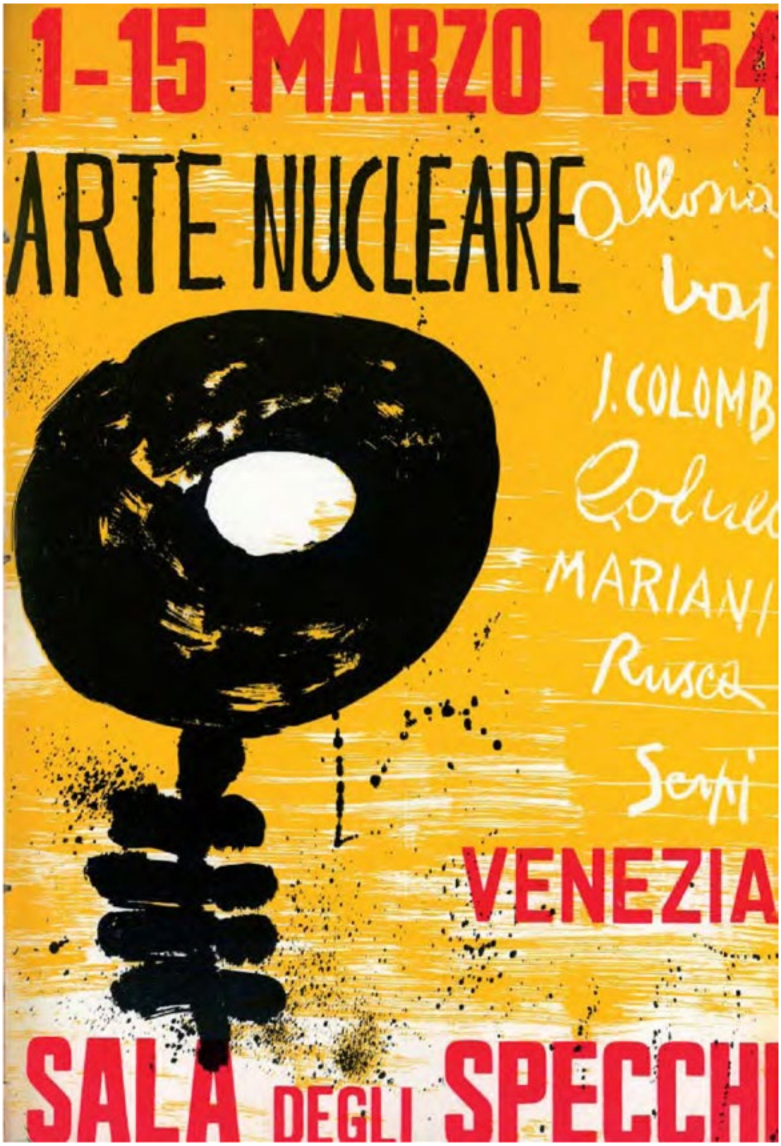

Figure 1 Poster for the "Nuclear Art Show" at the Sala degli Specchi, Venice, March 1954. In the spirit of the Italian Republic's recovery and industrial relaunch, the poster showed how the artistic avant-garde was enthusiastic about nuclear development for Italy.

Nuclear power in Italy at the height of the electric oligopoly

The Suez Crisis of 1956, which occurred between the conference in Venice and the signing of the treaty, also had some influence on the question of nuclear power in Italy. The Egyptian nationalist government had asked the World Bank for a loan to build a second dam on the Nile, but the funds were denied, and in retaliation Egypt nationalized the canal; the ensuing war witnessed Egypt lose against Israel, Great Britain and France. Although the coalition was soon to be politically defeated, the canal was closed from October 1956 to March 1957, complicating matters for the oil tankers traveling from the Gulf to Europe, and thereby showing the frailness of the supplying lines for the electro production of fuel. The Italian government had presented a project to build a power reactor in the south of Italy, competing with the Egyptian project of new dam.

In December 1956 SELNI accepted Westinghouse's offer for an enriched uranium pressurized water reactor. Its initial 134 MW of power was destined to increase several times to reach 270, since before the agreement was signed, lengthy institutional and technical steps needed to be taken. The main hindrances were the search for a site and finding the funds to build it. SELNI had asked Eximbank for a loan, which would have granted it through Istituto Mobiliare Italiano (IMI, Italian Real Estate Institute), a public bank that had managed the ERP funding. Therefore, although SELNI had been the first to plan the reactor, it was not the first to implement it (De Paoli in Castronovo 1994, 109–142). During that same year, FIAT and Montecatini had founded the Società Ricerche Impianti Nucleari (SORIN, Nuclear Plant Research Company), which owned a research centre in Saluggia, in the province of Vercelli, where they were planning to carry out a large industrial investment using American technology. In March 1957 the companies that had left SELNI, along with other companies controlled by the IRI, founded the Società Elettronucleare Nazionale (SENN, National Electronuclear Society), with the aim of building a power reactor in the south of Italy. As the economic backwardness of Southern Italy had been a critical part of Italy's economic history since the creation of the Kingdom of Italy in 1861, the intentions behind a public intervention that would contribute to the development of the South was obviously a contrast to those driving the private initiative of the industrialized North. In the same month, the state owned Ente Nazionale Idrocarburi (ENI, National Hydrocarbon Public Company), the main economic actor in the oil sector, joined the project. In an action that seemed to emerge out of the Suez crisis, although actually representing a much more complex strategic choice, ENI created the Società Italiana Meridionale per l'Energia Atomica (SIMEA, Southern Italian Society for Atomic Energy) through AGIP Nucleare, the nuclear arm of Azienda

Generale Italiana Petroli (AGIP, General Italian Oil Public Company). In London, in May that same year, Enrico Mattei, president of ENI, met with representatives of the British nuclear industry, assessing offers for the reactor that SIMEA would soon build, therefore opting for British technology and thus for the natural uranium graphite moderator (Rigano 2002, 11–21).

At the insistence of the Ministry of Industry, in June 1957 CNRN advised on the SELNI project; nevertheless, they recommended that the Italian government's approval should be subject to the results of a safety plan and a feasibility study of the site provided by SELNI. And it was exactly the choice of the site that made the decision hard: the site of Trino Vercellese, in Piedmont, was only chosen in 1960 (Paoloni 2009, 70).

The state owned companies promoting nuclear plants generally had an easier time finding sites and realizing their plans. In July 1957 the World Bank drew up an agreement with the Italian government to build a nuclear plant in Southern Italy; its funding would come from a loan by the World Bank to the Cassa del Mezzogiorno, a public body created in 1950 to fund infrastructural works in the south of the nation. The project was called Energia Nucleare Sud Italia (ESNI, Southern Italy Nuclear Energy), and it was the first feasibility study into building a nuclear plant in the south of Italy that was carried out by CNRN and the International Bank for Reconstruction and Development experts; SENN was given the task of building the plant (Rigano 2002, 21–40).

The final showdown between the public and private sectors in the Italian nuclear programs occurred in the following months, marked in September 1957 by the breach between CISE and CNRN regarding the agreement for the site in Ispra. Increasingly dominated by Ippolito, CNRN had acquired the personnel it lacked before, despite the fact that it did not have legal status and had to act through the NUCLIT Corporation. CNRN technicians, who had started cooperating with those of CISE, began clashing with the site management, and CNRN had NUCLIT hire CISE technicians. CNRN thus became the main protagonist of the Italian nuclear programs, asserting itself not only in the private sector, but also over ENI, thus solving the internecine conflict within the government about nuclear energy (Paoloni 2009, 67–68). As a reaction to SIMEA's choice to accept the offer made by the British Nuclear Power Plant Company (NPCC), SENN looked exclusively to the US market. CNRN only approved the SIMEA project in June 1958, and in October of the same year, in the province of Latina, the building of the SIMEA plant began: the plant was to house the 200 MW reactor Magnox (Elli 2011, passim).

During the course of 1957, CISE designed the CISE Reattore a Nebbia (CIRENE, CISE Mist Reactor) project, a prototype of a heavy water natural uranium reactor, cooled with light water, resulting in steam during the shifting phase, hence the name "mist". The project was funded by Euratom, and later entrusted to Ansaldo Meccanico Nucleare (AMN, the nuclear branch of the Ansaldo group); the entire operation would be carried out in Italy, thus meeting CISE's crucial target.

In September 1958 SENN chose General Electric's offer for a 160 MW boiling water reactor (BWR) fueled by enriched uranium. Construction started more than a year later in the Garigliano area of the province of Caserta. And it was only in July 1961 that the construction of the SELNI reactor started.

What was peculiar about these investments, which were supposed to render Italy one of the countries with the largest installed power capacity, was the difference between the systems of the three reactors. There is no agreement in the opinions on this unique situation. On the one hand, there is the dispute about the diseconomy that having three different systems entailed, enhanced by the fact that two reactors belonged to the state and the third belonged to private and public shareholders. Moreover, the two state owned reactors were very close to each other, which made the project to develop Southern Italy debatable because of the odd supply to the whole Southern Italy electric grid. This was a sign of the government's lack of strategic coordination, and the inadequate power CNRN had in determining political choices (Lombardi 1996, 589–644). On the other hand, once the three systems had been experimented with, there was the opportunity to choose where future investments should go, as at the time, there was no previous experience with the functioning of the reactors. Also, according to CNRN, the three different systems would make it possible to train Italian technicians who would be able to manage all the main reactors the market was offering (Paoloni 2009, 73).

At the end of 1957, CNRN brought together all the works of its commission in a white paper that was supposed to be the basis for a much sought after five year development plan for Italian nuclear power. The paper included the building of a large particle accelerator in Frascati, in the province of Rome, that would be entrusted to the INFN. The committee had started working on a national research centre in Lazio that would not be a copy of the one in Ispra, as the latter's project had changed. To understand the change in strategy at Ispra we need to take other factors into consideration: once the personnel were trained, CNRN's next target was to create the industrial capacity to build all the parts needed for nuclear plants in Italy itself. This national industrial strategy was consonant with the strategy of acquiring the competencies needed to manage and control the nuclear fuel cycle.

Therefore, a project to build another prototype of a national power reactor was launched. CNRN chose an even more innovative system, an enriched uranium reactor moderated and cooled with a mixture of diphenyl and terphenyl, i.e., an organic liquid. The building of this reactor involved all the parties active in Italian nuclear power: ENI, FIAT, and Montecatini, which through SORIN and AGIP Nucleare would be contacted by CNRN. The project was named Progetto Reattore Organico (PRO, Organic Reactor Project), and for the first fuel charge of the reactor it would recourse to the collaboration with Baltimore's Martin Marietta Corporation; another collaboration with the US for PRO was pursued with Atomics International, which was working on a similar plant. The subsequent fuel charges would be produced in Italy, relying on the successful progress made by the various projects in the sectors of fuel cycles that the Italian parties were participating in. Both CNRN and SORIN were members of Eurochemic, created on the initiative of the Nuclear Energy Agency (NEA) of the OECD, which had created a plant for isotope separation in Mol, Belgium (Lombardi 1994, 589–644). CNRN gave the research reactor located in Ispra, called Ispra 1 and finished in March 1959, to Euratom; the latter had its first real address there, as it started the Joint Nuclear Research Centre, its operational site, in Ispra. The donation marked Italy's sizeable participation in the European plan: it was met with protests in Italy but it was also an investment in European nuclear integration on the part of CNRN, and not merely a political one. In fact, Euratom immediately started the project known as Organique Eau Lourde (ORGEL) to build two prototype heavy water reactors cooled with organic liquid, that were supposed to simplify the Italian system of PRO (Geiss 2011, 17–22; 40–45). The first reactor was the ORGEL critical experiment (ECO), on which building started in 1962; the following year the building of the second reactor, ESSOR (Essai ORGEL tests), was entrusted to a consortium that brought together the Groupement Atomique Alsacienne Atlantique (GAAA), the German company Interatom and the Italian company Montecatini.

In November 1959 CNRN invested in research on the uranium thorium cycle, in a project later named Programma Ciclo Uranio Torio (PCUT, Uranium Thorium Cycle Program), and perfected thanks to the research in reprocessing, for which the building of the pilot plant Enriched Uranium Extraction (EUREX) in Saluggia, in the province of Vercelli, was arranged. The building of EUREX only started in 1965, when Eurochemic expanded its activity to include fuel reprocessing in 1966, thus depriving EUREX of the purpose of its existence. PRO was abandoned too, in favour of the research into fast breeder reactors (FBRs) that led to the project Prova Elementi Combustibile (PEC, Fuel Element Testing), which aimed to build a reactor on the same site as the PRO, on Lake Brasimone. PCUT was abandoned in the early seventies, leaving only PEC and CIRENE as large projects in applied research (Lombardi 1994, 589–644).

CNRN had become a public body with a considerable budget and about 1,700 employees; in August 1960 it became the Comitato Nazionale Energia Nucleare (CNEN, National Committee for Nuclear Energy), which took over NUCLIT and the Immobiliare Ispra (Ispra public owned company for real estate). CNEN was chaired by the Minister of Industry and governed by a board of directors. Ippolito was confirmed as general secretary; thus he was managing an actual body, similar to those of other nations. Nevertheless, CNEN did not fall under the framework of a nuclear law, which Italy would only approve two years later, in a scenario that would prove very different from the hopes that had emerged in the era of Italian nuclear euphoria (Paoloni 1992, passim).

The building of the SELNI plant in Trino Vercellese finally began in July 1961: the first plant to have been planned was in fact the last one to be built.

Nuclear power in Italy after the nationalization of electric power

The notion that electric power could be nationalized took shape since the end of the fifties. In addition to straightforward opposition to nationalization, internal debates and clashes were also heating up among the promoters of nationalization regarding the measure of the control the state would have over it. Amintore Fanfani, the Christian Democrat head of government and a proponent of nationalization, suggested the creation of a national electric body connected with ENI. IRI opposed this idea because its subsidiary company Finelettrica was already heavily involved in the Italian power industry. The Christian Democrat economist Pasquale Saraceno claimed that Finelettrica would purchase the private power companies, placing them under public control. The option of creating an autonomous body prevailed instead: the body would not be subject to ENI, and it would expropriate the private electric companies, compensating their owners. Ente Nazionale Energia Elettrica (ENEL, National Trust for Electric Power) was eventually established in December 1962; the body expropriated and compensated the power companies with more economic advantages than the IRI would offer, and therefore resulting in a larger mortgage for the new body (Castronovo 2012, 281–297). The engineer Arnaldo Maria Angelini, president of Finelettrica and vice president of CNEN, was appointed CEO of ENEL, while Felice Ippolito was also set to participate in the management of the new body.

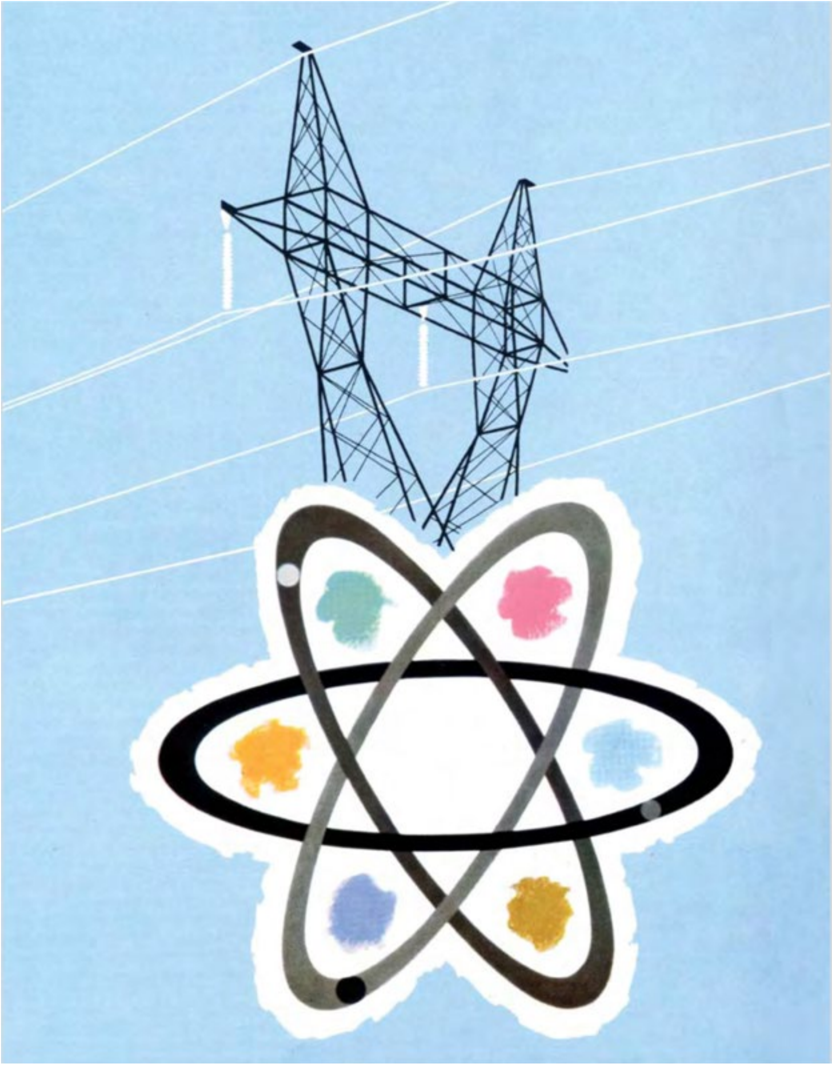

Figure 2 Graphic illustrating the use of nuclear energy to generate electricity, in the journal *Europa Nucleare*, 1961. The nationalization of electric power was a turning point in the Italian history. The political meaning of such decision affected a wide front of cultural and social actors, oriented toward the centre left government.

In October that same year, Enrico Mattei, CEO of ENI, died in a plane crash and the role of the company was limited and reduced (Colitti 1979, passim).

Once electric power was nationalized, the Italian parliament was able to work on the nuclear law that was approved soon afterwards, in December 1962. The law on the civil use of nuclear energy defined CNEN's field of action – applied and fundamental research – and the controls on the nuclear plants, integrating the law on the nationalization of power into the allotment of competences relevant to nuclear power. CNEN was given the task of developing applied research on every type of reactor and made responsible for all activities connected to research. It was also in charge of reactors safety, and had the power to express previous binding assessments on the plans for and location of future reactors. ENEL would instead develop electronuclear production, deciding on the building of new plants, assessing industrial offers and signing contracts for plants and fuel; moreover, ENEL was in charge of the functioning of the reactors. Indeed, with nationalization, ENEL took over both the private shares of the reactors still underway, and the management of the public owned power reactors.

At the end of that same month, the SIMEA reactor went critical: the Magnox reactor at the plant in Latina was the first reactor activated in Italy; it derived from the one in Bradwell on Sea, in England. The first parallel connection occurred in May 1963; in December that year it reached full power, and in January 1964 it started commercial production. The new power line Rome–Latina–Garigliano–Napoli, linking the two metropolises to the axis of the two nuclear plants, had been built the year before by ENI IRI holding. The reactor at the SENN plant in Garigliano (boiling water reactor type), built following the model of the Dresden plant in Illinois, went critical in June 1963, and it started commercial production in May 1964. The following month the reactor at the SELNI plant in Trino Vercellese (pressurized water reactor type) went critical, and the first parallel connection occurred in October, while commercial production started in December 1965. The reactor prototype was the same as the Yankee plant in Rowe, Massachusetts (Lombardi 1994, 589–644). All the private companies participating in SELNI had been nationalized, as had CISE. The difference between SELNI and the other nationalized companies was the fact that Electricité de France (EDF), a foreign public body, was a participant in the company. The French power body was interested in learning to manage a 270 MW PWR reactor. The reactor in Trino Vercellese was one of the most powerful in the world and the most competitive among the Italian reactors (Paoloni 2009, 93–100).

In August 1963 the Social Democrat Giuseppe Saragat started his press campaign against the management of CNEN and against the large amount of funding dedicated to the electronuclear sector. The attack concentrated on Ippolito and his allegedly bad management of the funds. The section of the press that was in favour of private industry supported the campaign, while the left wing press defended Ippolito. The Christian Democrats split in two, possibly because of the clash between two different understandings of the centre left, and therefore of nationalization, as Saragat claimed in an interview in the same month. Accusation against Ippolito, connected both with the management of CNEN and with the companies linked to his family, caused Ippolito's lawyers to intervene. His participation in the management of ENEL was questioned first, and then his position as general secretary at CNEN, from which he was suspended at the end of August that year. In September 1963, the public prosecutor of Rome initiated legal proceedings against Ippolito, who now also was suspended immediately from his position at ENEL (Curli 2000, 91–105). The trial sharply diminished CNEN's position at a decisive moment for nuclear power in Italy, in particular when it came to planning future investments. Italy was at the forefront of the debate on the competitiveness of nuclear power, whose cost per KWh was much higher than that of electricity from hydrocarbons, to remedy which Ippolito was suggesting a substantial project of public investment in the sector. His suggestion came into conflict with ENEL's budget problems, as it had to pay compensation for the oligopolistic companies expropriated on nationalization; therefore, both because of the CNEN crisis and the management of the nationalization, the investments in the nuclear sector were not adequate to ensure its economic competitiveness (Castonovo, Paoloni 2012, passim).

The US nuclear reactors at Garigliano and Trino Vercellese posed more functional problems. Trino underwent two long interruptions, while Garigliano was definitively closed down in 1981. The Magnox reactor did not experience significant interruptions, but due to the corrosion of several parts of the reactor, its power decreased by 20%. Both the interruptions and the loss of power negatively affected the competitiveness of electronuclear production compared to hydrocarbon based power. We must consider the economy stemming from the state's monopoly on electricity, completely realized in 1966, which gave to the ENEL an installed nuclear power capacity of over 600 MW; this had allowed Italy to become the third ranked nation in the world in terms of electronuclear production, at least during the Geneva conference on nuclear energy in 1964 (Paoloni 2009, passim).

In March of the same year the investigations ended, and Ippolito was arrested and put on trial; the Italian and foreign press disapproved of the investigating magistrate's attitude, and the sentencing of Ippolito to 11 years in prison was considered excessive by most. Ippolito filed an appeal and was released in 1968 (Curli 2000, 107).

In 1967, ten years after it was first drafted, CIRENE took physical form on the Latina site where the Magnox reactor was located, a 40 MW (130 thermal MW) prototype. According to some sources, Italy became competitive in the electronuclear power sector in that same year, on the basis of the increase of orders for nuclear plants in the United States after the black out that paralyzed New York in 1966 (Lombardi 1996, 589–644). Nevertheless, in the five years after nationalization, not many projects had been planned in the nuclear sector: ENEL's priority was to electrify the nation and develop the country's electricity network. Only in 1967 did ENEL come up with a draft for the building of a fourth nuclear plant, as part of a large development project in the electronuclear sector, based on the projections of power demand in the future. In 1969 the offers by AMN and the General Electric Technical Services Company (GETSCO) were chosen for the building of an 850 MW boiling water reactor. The Italian nuclear law allowed for the rapid selection of Caorso, in the province of Piacenza, as the location destined to host the plant. In that same period, ENEL was evaluating the possibility of building a fifth plant, but in December 1969 the Court of Audits sent a report to the parliament describing ENEL's indebtedness, which caused the project to be temporarily halted. Building the fourth plant in Caorso started in October 1970 and ended in June 1976; the first parallel connection occurred only in May 1978, which was much later compared to the earlier plants, and the full power was achieved only in March and April 1980, respectively. The commercialization only begun in 1981; the delay was due to the new safety criteria provided for by the US government in the late 1970s, which influenced the procedures for making and charging the reactor, and therefore the building of the plants. Still, the project to build a fifth plant was resumed while works to build the Caorso plant were ongoing, after Agelini's decision in April 1972 to involve ENEL in the building of two plants in 1973 and another two in 1974. The call for tender opened in December 1972, and in November of the following year ENEL was able to assess the proposals for a 800/1000 MW plant, to which, on ENEL's suggestion, a second power unit would be added, built by the winning party, and a twin reactor installed in the same plant. ENEL required a natural uranium and heavy water system, since, like France before, it had decided to abandon the gas graphite system of the Magnox. The contenders were Westinghouse, General Electric, and most notably Atomic Energy of Canada Limited, who had built the Canadian Deuterium Uranium (CANDU) reactor. In February 1973 ENEL had selected all the locations in Italy that were destined to host the future reactors, as evidence that the project of nuclear development was being resumed. General Electric obtained the contract, as the company was considered more competitive, and also because the issues at the Garigliano plant had not fully manifested themselves yet; the US company also obtained the contract for what would be the fifth and sixth plants (Paoloni 2009, 100–112). In December of the same year, the corporation of advanced Italian nuclear reactors NIRA was founded, with AMN holding the majority stake; the latter would build CIRENE and PEC (Curli 2002, 109–142).

From 1969 to 1975 the course of the military uses of nuclear energy in Italy was concluded by the signing of the nonproliferation treaty in January 1969, added to with a protocol of 12 reservations, and eventually ratified six years later, in May 1975 (Nuti 2007, 287–345).

From the 1973 crisis to the present

The oil crisis of 1973 and the economic crisis in Italy led the parliament to grant ENEL the means to face such economic turmoil. For the first time since WWII, inflation had reached two digit numbers, and the 250 billion lira five year fund no longer offered resources for investments that were adequate to realize what had been planned. Nuclear power had nevertheless acquired new popularity due to the decrease in fuel stocks; therefore the project to develop a national reactor was resumed despite the nation's financial straits. From the point of view of the regulations, parliament approved a law that allowed ENEL to invest in international consortia; thus the Italian utility was able to participate, together with EDF and RWE, in NERSA, the company that would build the FBR Superphénix reactor, and in ESK, which was supposed to build the FBR SNR 2 in Germany. In the summer of 1974, AMN received the order to replicate the fifth and sixth plants, and therefore build a seventh and an eight plant. The fifth plant was supposed to be located in Molise, and the sixth in Lazio, each with two reactors; to hasten the building process parliament approved a law in August 1975 that simplified the bureaucratic procedures, confirming that this was a tool the state could use against possible objections from local bodies. In December that same year, for the first time the government issued a document that would define the path of Italian energy policy, the Piano Energetico Nazionale (PEN, National Energy Plan). Based on estimates of the demand for electric power, the document included the possibility of reaching twenty 1000 MW plants by 1985, the so called nuclear islands (Lombardi 1996, 589–644).

In June 1976 ENEL and CNEN signed an agreement to build the CIRENE reactor, in a renewed effort to build a national reactor.

In 1977 parliament approved a project to find locations for the eight 1000 MW nuclear plants decided on by ENEL, and in December of that year the Comitato

Interministeriale Di Programmazione Economica (CIPE, Interministerial Committee for Economic Planning), amended PEN, lowering the electronuclear share for 1985 to 6000 MW. The data on the decrease in demand for electric power was important, of course: when Italy was first electrified, experience suggested that a doubling of demand every 10 years was a realistic prospect, but the 1970s were different. The Italian nuclear industry was now firmly established and able to meet the needs of the country, but what halted the realization of the planned nuclear plants was the objections of local bodies, such as those that, in the second half of the 1970s, stopped the building of the plant in Molise, the nuclear island that was supposed to host the fifth and sixth reactors. The local bodies approved the plant in Alto Lazio, and in particular on the site of Montalto di Castro, although some of the population started opposing it, delaying the start of building works until 1982. This nuclear island was supposed to have two 982 MW BWRs, and would be built by the AMN (Lombardi 1996, 589–644). The construction of CIRENE began in 1980 and was finished in 1986; the reactor had attracted the interest of the kingdom of Iran and the governments of Kuwait and Indonesia. The thermal hydraulic tests were successfully carried out in 1989, but the nuclear core was never charged with nuclear fuel.

In 1981 the Italian government revised PEN, this time confirming that only three new plants would be built according to a Unified Nuclear Project (PUN) that established standards for all the new PWR plants. ENEL would order and manage the plants, AGIP Nucleare would supply the fuel, AMN would be the main manufacturer and cornerstone of the industrial consortia that had been put together to meet several needs, and CNEN was in charge of controls and safety. As a matter of fact, in 1982 CNEN was turned into the Comitato Nazionale per la Ricerca e lo Sviluppo dell'Energia Nucleare e delle Energie Alternative (ENEA, National Committee for Research and Development of Nuclear Energy and Alternative Energies). In March that same year the reactor at Garigliano was closed down permanently. In November 1986 the reactor in Latina was closed down as well, and parliament approved the new PEN, planning for a twin reactor in Trino and the installation of another 4000 MW of capacity in Veneto, Sicily, Campania and Basilicata (Paoloni 2009, 118–124).

In the meantime, the antinuclear movement among environmentalists and local communities was now strongly connected to the pacifist movement, united against the deployment of the Euro missiles in Italy, which parliament had voted for in December 1979 and carried out in the mid-1980s. On an institutional level, the shift towards opposing nuclear power occurred after the Chernobyl disaster: among the abrogative referenda of November 1987, three were proposed by the

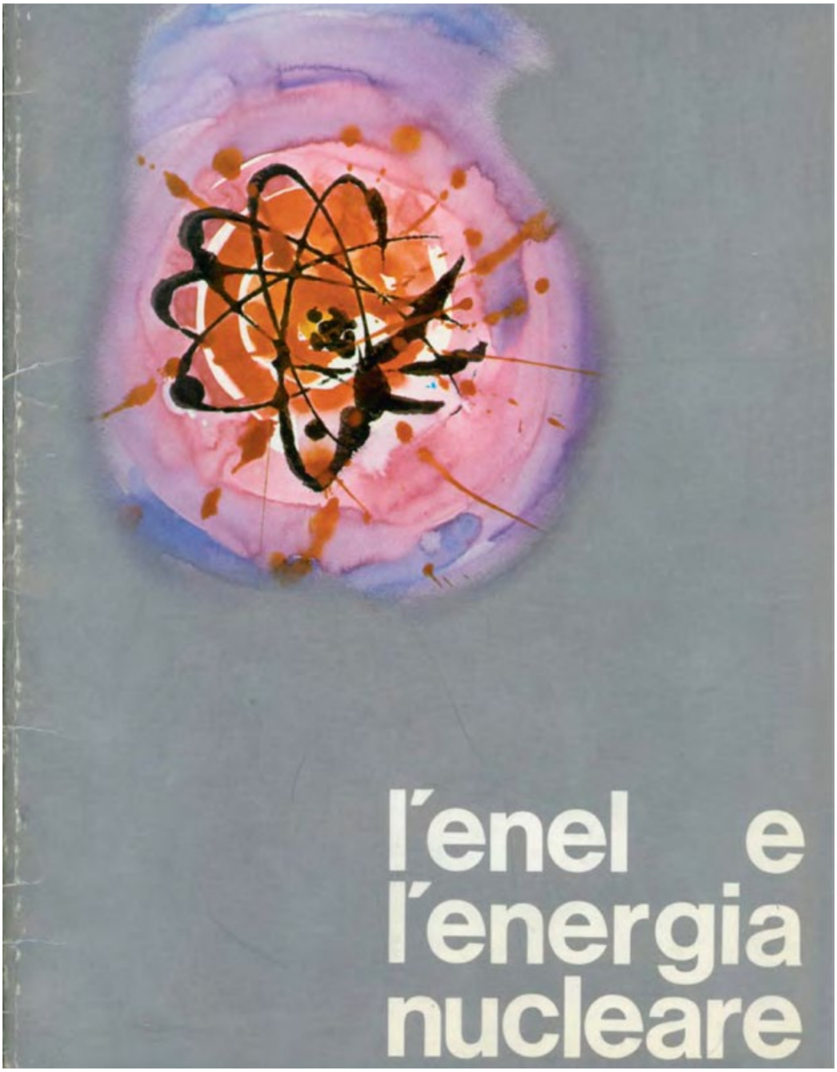

Figure 3 This illustration shows the cover of the journal *L'Enel e l'energia nucleare,* 1987. This issue appeared in the same year that the referendum on nuclear energy took place. It was the last issue of the once numerous journals on nuclear power. It is evident that fine illustrations were abandoned. After that year, nuclear publications were strictly technical without the appealing images of previous years.

Radical Party who supported the demands of the antinuclear movements. The first asked for the elimination of CIPE's prerogative as regarded the location of the plants, should the local bodies fail to reply within the deadlines provided for by the procedure. The second asked for the abrogation of the compensation paid to the local bodies that hosted nuclear or coal (not hydrocarbon) plants in their territories. The third asked for ENEL's withdrawal from the participation in international consortia for the building and management of nuclear plants abroad (Gerlini 2012, passim). (Figure 3)

The referenda were successful, and although they effectively blocked the location of new plants and ENEL's participation in the FBR project, politicians interpreted them as a mandate to abandon the nuclear project. As a matter of fact, the referendum blocked the building of the plant in Montalto di Castro, but in 1988 the government, a five party coalition chaired by the Christian Democrat Giovanni Goria, ordered the works to be resumed. The Socialist party was in the coalition, but it disagreed with the decision of resuming the works in the plant. Subsequently the government's downfall happened the same year and Montalto di Castro was converted into a thermoelectric power plant in 1989. CIRENE, technically ready to begin operation, was kept on hold until 1994, when the government closed the plant. The plant in Trino Vercellese was stopped in 1987 and put in permanent shutdown in July 1990; the last fuel charge was sold in March 1987 (Lombardi 1996, 589–644). In 1991 ENEA was reformed once again; keeping the same acronym, it changed its name to Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA, Institute for New Technologies, Energy and Environment). In 1999 all the Italian nuclear plants that had been closed down were transferred to the public company Società Gestione Impianti Nucleari (SOGIN, Nuclear Plant Management Company). In 2003 the Italian and Russian governments drew up an agreement to entrust the decommissioning of nuclear submarines to SOGIN. The embarrassing heirloom of a group of reactors under decommissioning seemed to disappear in 2009, with a law that potentially could have allowed Italy's nuclear adventure to be resumed, and then with a subsequent law in 2011 that occurred on the eve of a second referendum called by associations for the environment and common heritage. Among the questions posed, only one addressed the abrogation of the sections of the law relevant to the reopening of nuclear plants, and the opposition won once again. Neither in 1987 nor in 2011 was there significant support for nuclear power, neither from the mass parties of the First Republic, nor from the lighter parties of the Second Republic. The left parties were mostly against nuclear power in both plebiscites, despite having favoured it during Ippolito's time, while the right parties were mostly tepidly indifferent.

Main actors

CIPE Comitato Interministeriale di Programmazione Economica (Interministerial Committee for Economic Planning) was the governmental body established in 1967 to steer the political economy of the state. It comprised the chief of the government, the Ministers of Economy, Foreign Affairs, Economic Development, Agriculture, Infrastructure and Transport, and Welfare.

CISE Centro Informazioni Studi Esperienze (Centre for Information, Studies and Experience), founded in Milan, on December 19, 1946. This private company brought together a group of technicians and scientists from the academia and from the largest Italian electricity company, Edison. It was financed initially by, in addition to Edison, Fabbrica Italiana Automobili Torino (FIAT) (Italian Automobiles Factory, Turin), Cogne, Montecatini, and Società Adriatica Di Elettricità (SADE) (Adriatic Electric Company).

CNEN Comitato Nazionale Energia Nucleare (National Committee for Nuclear Energy) as CNRN became CNEN in August 1960. CNEN was chaired by the Minister of Industry and governed by a board of directors. Felice Ippolito was its general secretary, as it was an actual state body, similar to those of other nations. In 1982, CNEN became ENEA, a public body which inherited CNEN's former role in nuclear research as well in alternative energies.

CNRN Comitato Nazionale Ricerche Nucleari (National Committee for Nuclear Research) as the first state body had no legal personality of its own; it was a mere advisory body to CNR, although it was not subject to it, falling instead under the authority of the Ministry of Industry.

DC Democrazia Cristiana (Christian Democratic Party, DC) in conflict with each other. Regarding nuclear power, the party had staunch supporters and cautious opponents.

ENEA Comitato Nazionale per la Ricerca e lo Sviluppo dell'Energia Nucleare e delle Energie Alternative (National Committee for Research and Development of Nuclear Energy and Alternative Energies). After 1991 it became Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA, Institute for New Technologies, Energy and Environment). After 2009 it became Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Sostenibile (ENEA, National Agency for New Technologies, Energy and Sustainable Development).

ENEL Ente Nazionale Energia Elettrica (National Agency for Electricity) was created on July 26, 1962, with the nationalization of electric power. It expropriated and compensated the power companies, becoming the owner of all the Italian nuclear power reactors.

ENI Ente Nazionale Idrocarburi (National Hydrocarbons Authority), founded in 1953, was a state company and the main Italian player in oil and gas. The company invested abroad in oil and gas reserves, as well as in the nuclear sector. From the 1970s, it was in charge of nuclear fuel management.

IRI Istituto Per La Ricostruzione Industriale (Institute for Industrial Reconstruction) founded in 1933, instigated by Benito Mussolini and planned by Alberto Beneduce, with the intent to avoid bankruptcy of the main Italian banks and companies and thus the collapse of the economy, already suffering as a result of the global crisis that erupted in 1929. After WWII, the Institute was the lead player in the reconstruction and then the economic miracle.

PCI Partito Comunista Italiano (Italian Communist Party) was the main opposition party and the biggest of the left parties in the First Republic. Pro nuclear from the Ippolito trial up to the Euromissile crisis, it turned against the nuclear power in the referendum of 1987 under pressure from pacifist and ecologist movements.

PLI Partito Liberale Italiano (Italian Liberal Party) was a liberal, Western oriented centre right party, against the nationalization of the electric power.

PR Partito Radicale (Radical Party) was a splinter group of the Liberal Party, which during the years of the protests endorsed the civil rights struggle, e.g. for divorce or abortion. It promoted the referendum against nuclear power.

PRI Partito Repubblicano Italiano (Italian Republican Party) was a liberal, Western oriented centre left party, which kept the pro nuclear stance up to the referendum against nuclear power.

PSDI Partito Socialdemocratico Italiano (Italian Social Democratic Party) was a right wing splinter group of the PSI, which split before the 1948 elections. Its leader, Giuseppe Saragat, was the main accuser of the CNEN chairman Felice Ippolito.

PSI Partito Socialista Italiano (Italian Socialist Party) was the older Italian leftist party. It experienced various political shifts during the First Republic, from losing in the first political elections of 1948 as part of the Popular Democratic Front with the Communists, to the two centre left coalitions with the Christian Democrats, and to the five party coalitions of the 1980s.

Showcase

The three banded flag reactor

The most significant part of the history of Italian nuclear power is undoubtedly the search for a national reactor, which was to use the most advanced technology, based on the experience gained with the three different types of reactors operational in Italy. The technology would allow for a gradual separation of enriched uranium, and possibly even make up for the shortage of uraniferous resources in the area. Consequently, research focused on the various aspects of the fuel cycle control. This helped the Italian nuclear complex to become an international player and not just a technology importer and a client for the largest foreign industry.

The first actual project, in chronological terms, was the CISE Reattore a Nebbia (CIRENE, CISE Mist Reactor). Since its inception, CISE had devoted special attention to the use of heavy water as a moderator. Obviously, CISE's interest in heavy water derived from the possibility of using it to realize a power reactor that used natural uranium. The CIRENE program became a reality with the feasibility study, carried out at the end of the 1950s, of a reactor fueled by natural uranium, moderated by heavy water and cooled by boiling water, i.e., steam and therefore mist, in honor of the Milanese climate. It was at that time a very innovative solution, which preceded similar heavy water research by the Canadians, the British and the Japanese (Maiocchi 1996, 43–88).

The first sponsor of the CIRENE project was Euratom, who remained the lone sponsor for the first part of the 1960s, since CNEN did not consider this the top project in which to invest resources in order to develop a national reactor, instead finding research on FBRs and thus on the uranium plutonium cycle and the uranium thorium cycle more promising. Therefore, CNEN invested in another project for the national reactor, the Prova Elementi Combustibile (PEC, Fuel Element Testing) project, namely the creation of an FBR at Lake Brasimone, which supplanted the former Progetto Reattore Organico (PRO, Organic Reactor Project) (Silvestri 1968, 237–254; Ippolito and Simen 1974, passim).

It is rather difficult to precisely date the circumstances in which the PEC project acquired its final form; instead, bibliographical sources mostly agree on recognizing a progressive cooperation with French research into FBR, given the success experienced by the Commissariat à l'Energie Atomique (CEA, Atomic Energy Commission) whose first experimental sodium cooled FBR, RAPSODIE, had become operational in 1967 (Gerlini 2017, passim). In the same year, ENEL signed the first agreement with CNEN for the CIRENE project, defining the objective of the program as being the construction of a reactor already prototypical, albeit from 40 MW (Lombardi 1994, 589–644).

Both projects progressed slowly, compared to the speed of construction of the three plants already operating in the area, but from 1972 a series of events caused things to speed up. In the face of a change in the regime of fuel sales by US operators, and after the failure of construction of Euratom enrichment project, CNEN and AGIP Nucleare decided to participate (with 22.5 % of the shares) in the Eurodif consortium, encouraged by the CEA. The action showed the impatience with the monopoly held by the US uranium enrichment complex, even if the subsequent performance of the enriched uranium market crowded out the Eurodif consortium, whose participation of ENEL became uneconomical in the Italian government thinking (Lombardi 1994, 589–644).

In the same year, AMN was appointed head of the consortium for the construction of CIRENE on the Latina site. The order process was completed in 1973, providing to AMN a permanent position of the Italian nuclear complex. In 1974 AMN sold its fuel sector to ENI and it shared its subsidiary Nuclear Manufacturing Company (FN) of Bosco Marengo, in the Alessandria area, with AGIP Nucleare. The company's nuclear reactors (COREN), which were FIAT properties, followed suit, giving FIAT a guarantee of an exclusive supply of mechanics of processing plants for fuel elements. There were still not FBRs in commerce: the French Phénix prototype was commissioned in 1969 when work on CIRENE had not yet been initiated (Gerlini 2017, passim).

The international scene

The ability to invest capital in international consortia, which parliament had granted to ENEL, also entailed participating in the so called pact of the utilities. In December 1973, three big power utilities – ENEL, Electricité De France (EDF) and Rheinisch-Westfälisches Elektrizitätswerk (RWE) – called for the integration of the European aggregate FBR programs, to be focused around the French and the German nuclear complexes. In fact, just as the Italians had established cooperation with the French, the Germans had created a similar business arrangement with the Belgians and the Dutch, with the company Schnell–Brüter-Kernkraftwerksgesellschaft mbH (SBK).

So, the next year two companies were formed: the central Groupement Nucleaire Européenne à Neutrons Rapides (NERSA), which would build the Superphénix 1 reactor at the Creys Malville site, and Europäisches Schnell-

Brüter-Kernkraftwerk (ESK), which would construct the SNR 2 reactor at the Kalkar site. ENEL held 33 % of the shares in both the companies, but it was with the French part of the program that the Italian nuclear complex was integrated. In fact, in 1974 CNEN reached an agreement with CEA, which laid the groundwork for using the PEC testing of elements for Superphénix, thus abandoning not only the goal to make PEC the prototype for an Italian power reactor, but that of having an independent national FBR program. But it would be wrong to consider CNEN's choice as waiving autonomy or submitting to a plan led by CEA. This is because, firstly, after the pact of the utilities, the French and the Italians had rationalized their efforts, effectively creating an integrated European research program (Nau 1972, 518). Secondly, the Italian nuclear complex was encountering great difficulties in completing PEC, which at the height of these agreements was still under construction, with mounting costs that were far greater than had been planned for. Thirdly, the company that operated both PEC and CIRENE, the Nucleare italiana reattori avanzati (NIRA, Italian Advanced Nuclear Reactors), drew up an agreement with their French counterpart Novatome for the joint provision of NERSA, the boiler of Superphénix 1 (Paoloni 2009, 115). This was the first of a series of agreements from which the Italian nuclear industry benefited; they followed an agreement between NIRA and CEA for the sharing of knowledge in the systems engineering of FBR, an agreement between AGIP Nucleare and CEA for the sharing of knowledge on fuel, and various other such agreements between Italian and French industries regarding components, or more precisely, the reactor block and refrigeration circuits (Lombardi 1994, 589–644).

The agreements certainly worked, as the Italian companies furnished the agreed on components and Superphénix 1 started commercial production in 1986, as scheduled. What suffered fatal delays was PEC, which on December 31 of that year was 70 % completed; the work had cost 1.56 trillion liras thus far. In those ten years, however, the fate of the European FBR program was sealed, along with the fate of the reactors using heavy water and natural uranium, through an international framework that influenced the choices of governments and industry consortia (Lombardi 1994, 589–644).

On the one hand, there was the strengthening of nonproliferation policies by the superpowers, following the Indian nuclear tests of 1974. Since the bomb was made with plutonium produced by a CANDU, the entire heavy water, natural uranium chain was the subject of special political attention, which of course translated into reduced appeal on the international market. For the European FBR program, the proliferation risk was inherent in its fuel cycle, which was based on plutonium; both efforts received a serious disincentive as a result of the International Nuclear Fuel Cycle Evaluation (INFCE), which the President of the United States Jimmy Carter had given strong backing to in 1977 (Gerlini 2017, passim).

On the other hand, thermal reactors, in particular BWR and PWR, remained the cheapest type, out competing the gas graphite chain, especially with a very favourable enriched uranium market, which hardly provided incentives to develop alternative solutions, such as the use of natural uranium. These reasons combined to make PWR the choice for the single reactor for future Italian power plants, a decision formalized by the Progetto Unificato Nucleare (PUN, Unified Nuclear Plan) in 1981, but destined not to be put into practice. Indeed, the majority of Italian reactors remained BWRs, because those were the two reactors planned for the nuclear island of Montalto di Castro, as well as the Caorso and Garigliano plants. But the PUN's choice makes sense as well, as PWR was winning on the international market thanks to the performance achieved in nuclear propulsion, and France and the United Kingdom had already directed their industry towards PWR (Paoloni 2009, 118–123).

The implosion of the Italian nuclear power reactor program

These international events intersected with the domestic crisis in the national reactor project. Even if PEC had been subsumed into the European program, trying to offset its costs, the CIRENE reactor was still supposed to be an Italian designed reactor. Yet AMN was continuing its work with a minimum contribution to Canadian industry. The changed international context provided a disincentive for the commercialization of a new type of natural uranium reactor, and therefore in 1982 the government appointed a special commission to evaluate whether to continue or not the CIRENE program. The commission considered it uneconomic to interrupt the works, given the extent to which these had now progressed, but from that moment on, the CIRENE reactor was considered an Italian nuclear national exercise without any potential commercial value. Motivation for the project was lost and when in 1987 the reactor was ready for operation and absolve tests that had been conferred, the entire program was stopped by the referendum, leaving it fully and completely unused, a fitting emblem of the end of Italian nuclear power (Lombardi 1994, 589–644).

This was an end to, or perhaps an exit from, nuclear power, of which historiography has yet to produce relevant studies. The story of the national reactor exemplifies the divisions within the Italian nuclear complex, where competition

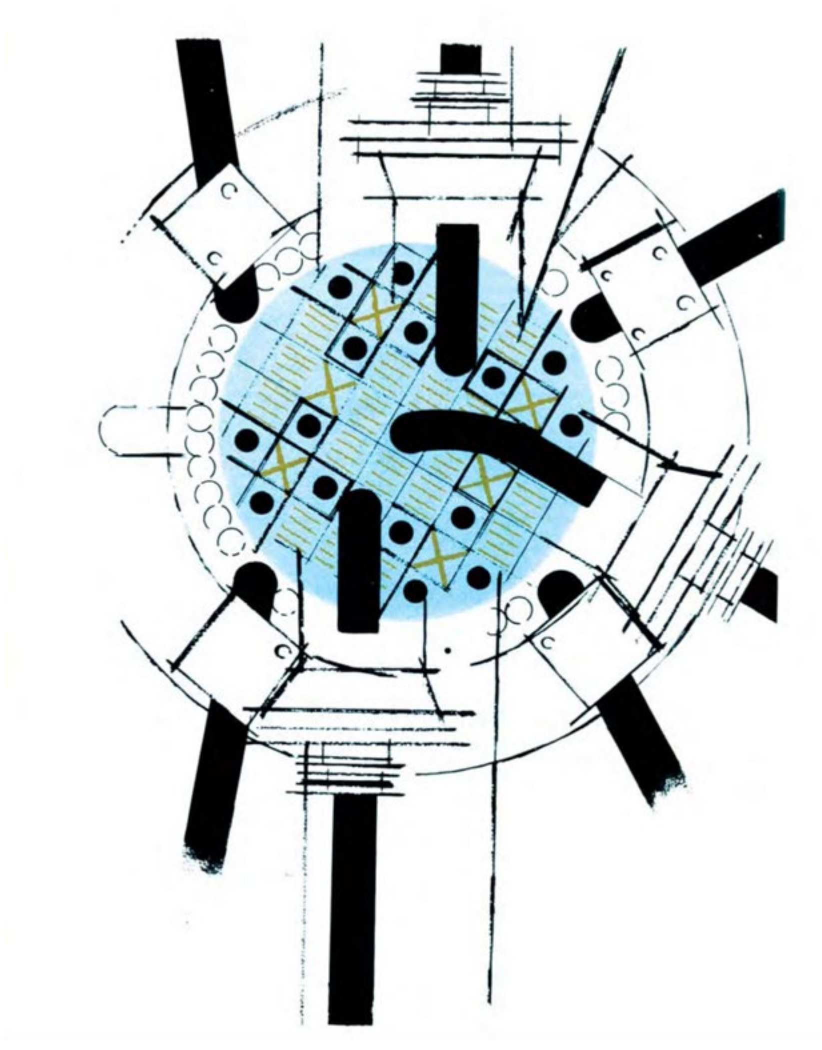

Figure 4 Illustration taken from the journal *Europa Nucleare,* 1962. It represents an artistic image, the core of a nuclear reactor, as a great achievement of science and engineering for Italy. This commitment to publishing abstract artistic images was a feature of this leading journal in the Italian nuclear community. The meaning behind this editorial choice was that nuclear power was advanced, convenient, and fine.

between centres and consortia was very marked. Analysis of it can no longer be considered resolved by attributing its failure to the insufficient development of Italy's nuclear industry because Italian industry had been fully competitive on an international scale since 1975. This sort of competition between various groups, which manifested itself in an antagonism between industrial sectors and between programs, cannot be considered specific to the Italian context. In addition, internal competition was very limited and channeled into a national system.

Empirically, it is possible to note that the attitude of the mass parties to nuclear power radically changed. This can be seen from a simple comparison of the positions expressed by the parties during the Ippolito case and during the referendum campaign of 1987, especially those of the socialists and communists. It is precisely on this plane that there is a lack of historical research based on primary sources. If it is empirically clear that the three major nuclear accidents in history had an effect on Italian public opinion, these are not enough to explain the course of events. The Three Mile Island accident significantly increased concern among and protests by local communities, but in 1979 the government had already acquired the legislative instrument necessary to compel local administrations. It is equally clear that accidents at Chernobyl and Fukushima influenced the vote in the referenda towards the rejection of nuclear power, as polls prove. The scholarship misses a comprehensive historical study on the change of position of the parties to the first referendum, although one may help explain the actual effects that the referendum had on Italian nuclear power, such as CIRENE not becoming operational.

At the moment, however, it is only possible to advance a reconstruction of events that establishes some logical connections, based on a nuclear whole definition covering both civilian and military uses. PCI had always been opposed to Italian military nuclear projects, although it had always supported the civilian ones, as the most significant exponents of nuclear physics, as Amaldi. Ippolito, who was pardoned by Saragat (then President of the Italian Republic), was himself elected to the European Parliament in 1979 from PCI lists. But also in 1979, the Italian Parliament approved the dual track decision – that is, the ability to deploy the new missile carriers, the so called Euromissiles, in Italy. PCI opposed the deployment, and when the protest movement against the missiles grew in the early 1980s to become a national force, the party leadership endorsed the concerns raised by the movement (Nuti 2007, 347–393). The protests, however, did not only consist of large national demonstrations in the capital, but took place on the sites that would host the missiles, far from the big cities. As far from the cities were the nuclear power islands, so this common grammar of protest facilitated the osmosis between the peace movement and the local demonstrations against nuclear reactors, supported by most of the Green movement. Environmentalism and pacifism had thus created a synergy against the two main uses of nuclear energy, weapons and electricity production, while, for example, the medical uses for nuclear technology were not disputed.

Both PEC and CIRENE could have been of great use to a national military program, but the troubled NPT ratification process had foreclosed that possibility. Both projects, then, were exposed to complex domestic and foreign factors that influenced Italian electricity production. In addition to PCI, DC also rapidly changed its positions, dropping its pro nuclear stance as the 1987 referendum approached. The PSI's change in position was somewhat less abrupt but equally significant, it being the third largest socialist mass party, and having been the party which had made the victory of the parliamentary motion on the dual track decision possible in the first place. In fact, it was only PSI who, in 1979, had taken that side on an issue that had caused great difficulties for other European social democratic parties, most notably in Germany, approving the deployment of the missiles after a hard internal debate. So, PSI was favourable to nuclear weapons, not as a national acquisition but as an element of international relations, at the same time as it was against Italian nuclear power. It should not seem a stretch to define the political parties as against Italian nuclear power, because this is, today, the only explanation for why all nuclear programs, including research in the field, substantially reduced after the 1987 referendum (Gerlini 2012, passim).

The referendum questions did not legally entail the end of the nuclear power tout court, but it made it more difficult, perhaps almost impossible, to find locations for new plants: it did not touch existing or already approved plants, which explains the attempt made by Giovanni Goria's Christian Democratic government to complete the nuclear island of Montalto di Castro and put it into operation. Certainly, denying the possibility for ENEL to participate in new international investments hit PEC hard, weakened both by the realization that it had encountered problems, and from the missed commercialization of European FBR. In both plant locations and international cooperation, there were no legal grounds to close all programs, if not a shift of attitude by the political leaders; this disinterest complicated the exit process from nuclear, both in terms of the renegotiation of international commitments on fuel supplies, and the management of the decommissioning of reactors and waste.

Events

The following five events were selected based on their relevance to the full history of the Italian nuclear complex. They are placed in the wider historical context, because a historical event can epitomize a long trend or maybe represent a turning point only if we are aware of its background as well as its consequences. Therefore, we are not looking for continuity in the human history, not suitable for this research topic, but on the contrary, we avoid a just chronicle approach which would not explain why an event was a turning point or a historical feature of the topic.

The events chosen are a tailored mix of quotations from three bibliographic sources: Gerlini (2012); Paoloni (2009); Gerlini (2016).

Event 1: The private sector as prime mover in applied nuclear research

The inception of applied nuclear research in Italy was marked by the foundation of the Centro Informazioni Studi Esperienze (CISE, Centre for Information, Studies and Experience). The organization had already been mooted before it was officially created in Milan on 19 November 1946: the idea had first been aired in August 1945, in the aftermath of news about the atomic bomb. Following a big conference held in Como in November 1945 on the suggestion of Luigi Morandi (an anti-fascist chemist and the man who was appointed to run the Montecatini firm after the liberation of Italy), Edoardo Amaldi drafted a report entitled "La fisica in Italia" (Physics in Italy), in which he stated his opinion about what needed to be done to develop peaceful applications of nuclear physics. Amaldi, who went on to become an exceptionally high profile figure in post war Italian physics, was part of Enrico Fermi's group. By the end of the war he not only had undeniable personal leadership in the scientific community, especially among physicists; he also held a prominent position among Italian and international scientific policymakers.

CISE was actually a partnership between, on the one hand, the full professor of advanced physics at Milan State University, Giuseppe Bolla, and his assistants Carlo Salvetti and Giorgio Salvini, and on the other hand, the manager of the Edison electricity company, Guido Molteni, the executive officer Vittorio De Biasi, and the young engineer Mario Silvestri.

A series of meetings between these six men commenced, at which academia was represented by Bolla, Salvetti and Salvini, and the Edison company by De Biasi, Silvestri and his boss, who was manager of the company's Technical Office.

In early 1946, Salvetti and Silvestri drafted a three stage plan. Stage one was simply to assemble a group of specialists who could research and work on the topic; stage two required setting off a very low power nuclear chain reaction; stage three consisted of building an experimental nuclear reactor of a certain size. Funding requirements were estimated at 10 million lire for stage one, 100 million lire for stage two, and 1 billion lire for stage three. To give some sense of scale to these figures, Silvestri recalls that at the time he was earning 18,000 lire per month, a sum that was considered a good wage (Silvestri 1968, 39).

Bolla suggested that the project – an enormously ambitious project considering the circumstances at the time – could be achieved by persuading potentially interested industrial enterprises to set up an ad hoc company. To get the project off the ground, they approached the largest industrial groups in Northern Italy: the big car company Fabbrica Italiana Automobili Torino (FIAT), the steel company Cogne, the chemical company Montecatini and Società Adriatica di Elettricità (SADE), which was Italy's second largest private electricity trading company after Edison.

This long series of events unfolded prior to 19 November 1946, when a deed was signed at the offices of a Milan notary that marked the beginning of CISE. The signatories that day were Vittorio De Biasi of the electric power company Edison, Teresio Guglielmone of Cogne, and Antonio Cavinato of FIAT. The founding partners contributed 40,000 lire each in share capital. De Biasi was appointed chairman of the new company, and Cavinato was offered the post of sole administrator. CISE took the form of a limited liability nonprofit making company. The funding parties each pledged to pay 6 million lire annually. The company's declared purpose was to acquire and exploit patents and therefore experiment in any scientific field. The company was initially supposed to continue until 1951. Not long after it was initially set up, SADE and Montecatini companies also signed up. The number of shareholders was destined to grow in later years, as other major Italian industrial groups joined: in 1949, it was Falck, Pirelli and Olivetti; in 1950, Terni. Within a short space of time, Vittorio Valletta joined the board as a representative of FIAT, bringing more weight than Cavinato could provide. Also in 1947, Gustavo Colonnetti, the chairman of the Italian National Council for Research (CNR), joined CISE board which was established to build a nuclear reactor for electricity generation purposes. It is worth noting that CISE was not a public body or agency, as the similar bodies established in the US, the UK, France and obviously the USSR were.

Back in 1946, CISE had to rely on designing and building a reactor under its own steam. After long discussions, it was decided to work on a 10 MW heavy water natural uranium reactor. A vast number of issues still needed to be resolved, however, not least where to obtain a supply of uranium and heavy water. Each of these items required brand new solutions to theoretical and technological issues, since Italy did not have access to information or results obtained by others, and was not eligible to license foreign patents. One of the most pressing problems for the development of nuclear research in Italy was the lack of qualified personnel, something that Amaldi had already pinpointed in his January 1946 report, in which, among other things, he set out a plan for properly training a sufficient number of staff. This issue was one of CISE's stage one objectives in Salvetti and Silvestri's planning document. During its earliest years, CISE served as a school for researchers more than anything else. Nevertheless, the main problem for CISE remained the definition of the overarching plan, owing to the scarcity of detailed scientific and technical information available on progress in the most advanced nations, particularly the United States: all such information was shrouded in the utmost secrecy. The most important thing was to gather all available information and undertake theoretical and experimental studies to understand the principles of how a reactor worked. The theoretical unit, headed by Salvetti, was responsible for this area of research, with the assistance of two laboratories, one for neutrons and one for ion sources, directed respectively by Ugo Facchini and Emilio Gatti.

By the end of 1951, CISE had achieved a number of important results. It had built a pilot plant to make heavy water through electrolysis, and created an experimental uranium metallurgy plant. Important measurements had been obtained in its uranium fission laboratories, and it had developed leading edge electronic instruments. Cogne had fallen behind in its payments and Falck was threatening to pull out altogether.

The state enters nuclear applications

By this time, the government was being lobbied on three separate fronts: by industrialists, who were seeking appropriate public funding for CISE's activities; by physicists, who wanted to stay abreast of international scientific developments; and by the military, who were asking for investment in nuclear weapons' research for Italy's defense and the emerging international scenario. With progress being made in other countries, all the parties concerned hoped that adequate state funding would accelerate development and restructure industrial and academic nuclear research in Italy. However, each of these parties was also jockeying for the lead in the putative new structure, rather than combining their efforts to put pressure on the political authorities. Thus, the government continued to postpone making a decision, and consequently continued to be lobbied on all sides. At the beginning of 1949, Edison Chairman De Biasi reiterated the company's opposition to seeking public funding because they wanted to keep CISE beyond the reach of government meddling and control. However, on that occasion he came up against opposition from Antonello Vittore, who represented SADE, the other large private electricity trading company involved in CISE, and Bartolomeo Orsoni of Montecatini. Edison had long been concerned that nuclear research could potentially become part of the debate about nationalizing the Italian electricity industry. However, De Biasi acknowledged how his fellow board members felt and agreed to go down the new path of seeking state funding, despite his skepticism about its chances of success. To implement this resolution, CNR Chairman Colonnetti joined CISE board as a sitting member, and put himself forward as a mediator in relations with the government in order to obtain the funding they sought.

We have to consider that the first attempt at a military application for nuclear energy began during these years, and it was met with the staunch opposition of nuclear physicists, Amaldi above all, as well as the suspicious opposition on the part of the electricity companies.

The long hoped for increase in state funding finally materialized in the 1950/1951 budget. Funding for the CNR was doubled from 265 million lire to 540 million lire. CNR invested a significant portion of its new funds into basic nuclear physics research. In July 1951, it founded the Centre for Experimental and Theoretical Nuclear Physics, under the directorship of Gleb Wataghin. Also under the aegis of CNR, the National Institute of Nuclear Physics was founded to coordinate activities at research facilities in Rome, Padua, Turin, and soon afterwards, a new facility in Milan. Though this solution enabled nuclear physicists to emerge from the uncertainties that had beset them since the war, there was no resolution in sight regarding the relationship between basic research into nuclear energy and nuclear applications. CISE's requests for funding went unfulfilled; the issue of relations between nuclear research and defense was not even broached. The scientific community decided to make one final political push and approached the Minister of Public Works, Pietro Campilli. Amaldi acted as go between, after contact was initiated by Francesco Giordani, Chairman of the CNR Chemicals Committee, and a man well trained in how the world of state run industry worked, having also been chairman of the main public industrial holding, the Institute For Industrial Reconstruction (IRI, Istituto Ricostruzione Industriale), from 1936 to 1943 and chairman of CNR from 1940 to 1943. Immediately after the war, he represented Italy in the upper echelons of the World Bank in Washington; he was also a friend of the Governor of the Bank of Italy Donato Menichella, who himself had previously worked as Director General of IRI. Campilli had been busy working on energy issues. A few months earlier, he had overseen the birth of Finelettrica, an IRI financial holding company for all state investments in the electricity industry. Amaldi, Giordani and Campilli came up with the strategy of establishing a National Committee for Nuclear Research by Prime Minister's Decree, which would be funded by IRI and the Ministry of Industry, and able to access resources from the Coal Committee. This approach would have avoided the necessity of going through Parliament, and therefore running the risk of further interference. Campilli's involvement proved to be crucial to establishing a National Committee for Nuclear Research. This formal move was soon followed by tangible action. The Ministry of Industry granted 100 million lire in funding to CISE through CNR, which was enough to balance the budget. Moreover, Colonnetti told CISE's board of directors that the state budget for 1952–1953 would contain 1 billion lire to support basic and applied nuclear research.

Colonnetti, however, was less than happy that CNR's role had been downgraded, not to mention the fact that physicists and industrialists were, in Giordani's view, to have a new go between. Colonnetti succeeded in getting the new Committee to report not to the Ministry of Industry, as Giordani and Campilli had been hoping, but to CNR, which pledged to help with funding by offering 250 million lire for the National Institute of Nuclear Physics. The time was ripe for the foundation of the first nucleus of state intervention in the nuclear energy, as a particular branch of CNR structure.

De Gasperi signed the decree that established the Comitato Nazionale Di Ricerche Sull'Energia Nucleare (CNRN, National Committee for Nuclear Research) on 26 June 1952. The Committee was chaired by Giordani, who was assisted by deputy chairman Modesto Panetti, an engineer at the Turin polytechnic university and a Christian Democrat senator. The committee included physicists of the caliber of Amaldi, Bruno Ferretti and Enrico Medi; high profile industrialists such as Vittorio De Biasi and Finelettrica Deputy Chairman Arnaldo Maria Angelini; senior civil servant Aldo Silvestri Amari (Director General of the Ministry of Industry); and a geologist who had specialized in uranium research in Italy, Felice Ippolito. Following established practice at that time, as the youngest and least academically experienced member of the committee, Ippolito was appointed Committee Secretary. The official CNRN founding ceremony took place at the Ministry of Industry on July 23, 1952.

Event 2: The roots of the first nuclear scandal in the world

The Italian promoters of nuclear power established a primary connection with the American nuclear complex, while the state owned CNRN overwhelmed the private owned CISE. Italian scientists participated in Euratom through the research centre of Ispra, as well in the international nuclear organization IAEA. Among the protagonists in the Italian nuclear adventure was Felice Ippolito. According to the opinion of the public did he promote the impressive developments in nuclear science. During those years, the nationalization of electric power changed the political landscape, and Ippolito was still a protagonist in this process. When he was put on trial and eventually jailed, the Italian nuclear program was also put on trial. It was the first time the public had seen a negative image of promoters of nuclear power. The scientists defended Ippolito, while the liberal oriented policy makers and managers were against him.

At a CNRN meeting on March 9, 1955, Giordani suggested sending a technical mission to the US to establish contacts with the US Atomic Commission, with a view to entering into a partnership agreement, in the spirit of President Eisenhower's December 1953 statement on atomic collaboration for peaceful purposes.

In meetings that took place on February 17 and July 12, 1956, CNRN resolved to commission CISE to look into the construction of a research reactor which would be purchased from the United States. They chose the reactor type (a CP 5, like the one at the Argonne nuclear labs), and contracts were approved between CNRN and CISE to install and run this reactor, along with a contract with American Car & Foundry to provide it. CISE was also issued with directives for acquiring the chosen site, near Ispra. The committee then resolved to appoint a commission to look into finding locations for nuclear plants. Sitting on the commission were CISE members, CISE itself, CNRN, the Ente Nazionale Idrocarburi (ENI, National Hydrocarbons Authority), which had recently set up AGIP Nucleare to build a power station, and the Società Elettronucleare Italiana (SELNI, Italian Electronuclear Society), a company established by Edison to build their planned nuclear power station.

At the end of July 12, 1956 session, Giordani announced that he would be stepping down as the chairman of CNRN. Notwithstanding his stated health reasons (which in truth were barely credible), Giordani's resignation was prompted by the committee's parlous financial situation. His resignation focused public attention and that of the political milieu on the future of nuclear power in Italy, which was already in the public eye in the wake of the Geneva conference. Giordani evidently wanted to force the government to come to a decision and end the climate of uncertainty that had been ongoing for the past year or so. His move spelled an end to political infighting between supporters of a stronger CNRN, and those who wanted the organization to be cut down to size.

At the end of July 12, 1956 meeting, CNRN accepted a proposal put forward by Ministry of Industry representative Aldo Silvestri Amari in which he nominated CNRN Secretary General Felice Ippolito and on July 20, the Italian Prime Minister Antonio Segni received Amaldi, Angelini, Ferretti and Ippolito, providing them his support.

CNRN was officially renewed in a decree issued by the head of the government on August 24, 1956. The decree contained a number of regulatory changes with respect to its 1952 predecessor. The new chairman was Basilio Focaccia, a full professor of electrical engineering at the University of Rome, who was also a Christian Democrat senator and a former government undersecretary for the Merchant Navy and Industry – most certainly a political figure. The new decree led to CNRN taking on a great many new members of staff. Up until the summer of 1956, the entire staff had consisted of secretariat employees seconded from CNR. By December 1956, the committee had gained its first (interim) general services administration. In July 1957, the committee's organization was subdivided into services (later designated as divisions), plus an account's office, all of which reported to the secretary general. The committee's growth was undertaken through a series of restructuring plans. Four such sweeping plans were put into effect (at a rate of one year). Ippolito was the man behind all of this.

With the blessing of the ministry and CNR (now chaired by Giordani), the committee proceeded to hire its own staff though in theory it should have drawn staff on secondment from the Ministry of Industry. This rapid growth led to a radical de facto change in the organization's administrative standing. The new CNRN met for the first time under Focaccia's chairmanship on October 23 and 24, 1956. On the agenda for the meeting were the questions of funding the building of a centre and a reactor in Ispra, Lombardy. The new CNRN began operations at a time when the international expectation was that civil nuclear applications were about to undergo rapid and imminent growth. The decision to build a nuclear research centre for the research reactor was taken in late summer 1955. Once the site was chosen, the Committee provided funds for its purchase through an ad hoc company (Immobiliare Ispra), whose managing director was CISE Director Federico Nordio. Several CNRN members sat on the company's board of directors. It was necessary to set up a private company to acquire the land because CNRN did not enjoy legal status. CISE was put in charge of constructing the facility buildings, as well as designing and building the reactor, which was commissioned from American Machine & Foundry. CNRN sent a group of its own technicians to join CISE technicians who were already in the US, led by Salvetti. In early 1957, following a number of disagreements between the technicians and Nordio, CNRN took on an increasingly prominent role in the construction of the Ispra facility. Tensions flared once more between CNRN and CISE, until CNRN made a decision to go it alone and build the facility itself. Relations between the two organizations were cut off in September 1957.

Once more, the committee found itself having to tackle operational problems arising from its lack of legal status. Once more, these problems were resolved by drawing on the committee's funds to set up a joint stock company, the above mentioned NUCLIT, which took on a large number of the staff formerly employed by CISE need to build the centre. Deprived of some of its technicians and of its main activity, CISE had to restructure its program of activities. In early 1958, Gino Bozza was drafted in to replace Giuseppe Bolla at the head of the organization. CNRN had finally taken a dominant position in Italy's civil nuclear industry. At the end of 1957, CNRN's research commissions submitted a series of reports on the results of their labors. These reports were combined to form a white paper, which then served as a five year plan for nuclear research in Italy. CNRN's core activity, however, was applied research: above all, building the necessary infrastructure. To achieve this, throughout the 1950s the organization's main priority was to set up the nuclear research centre at Ispra. However, almost immediately after this was completed in 1959, it was transferred to Euratom to serve as one of the common research facilities defined in that organization's founding agreements. By 1958, though, work had commenced on building another nuclear research centre near Rome: the future Casaccia Centre. This facility became the focal point for a whole series of activities in chemistry, electronics and radio biology, alongside several basic research programs. A great many activities and employees were transferred from the Ispra Centre after its transfer to Euratom.

Since its foundation, CNRN's stated objectives had included drafting industry wide legislation for the nuclear sector in order to regulate the complex and delicate technical aspects of the industry, and at the same time transform the committee into a nuclear body comparable to those that existed in other industrialized nations, especially as regarded its legal status and access to its own budget. However, converting these provisions into law met with widespread opposition owing to tensions triggered by the ongoing debate on nationalizing the Italian electricity industry. One of the committee's priority objectives was to obtain reliable funding within a more modern legislative framework. By this time, the committee had become a major research body with industry leading technical and scientific expertise that administered significant amounts of money and employed around 1,700 people.

The eventual autonomy of the Italian nuclear agency and its crisis

In the end, the idea of founding an organization for nuclear research was taken off the table during the drafting of general nuclear industry legislation, which made its way through parliament and in August 1960 led to establishment of the Comitato Nazionale per l'Eneregia Nucleare (CNEN, National Committee for Nuclear Energy). Among other things, the emergence of CNEN made it possible to resolve the anomalies that had been created by setting up a real estate company, Immobiliare Ispra, and NUCLIT; these companies transferred their assets to the new organization and were wound up. CNEN was chaired by the Minister of Industry, and run by an Executive Committee; Felice Ippolito was confirmed as General Secretary. The transitional law that led to the establishment of CNEN was not, as we noted above, the much needed overarching law on the nuclear industry; this did not find its way onto the statute books until later when the electricity industry was nationalized and Ente Nazionale Energia Elettrica (ENEL, National Agency for Electricity) was founded.

A new political era dawned in Italy at the start of the 1960s. One new development was an agreement in late 1962 to nationalize the country's electricity industry. Immediately after this decision was taken, the foundation of ENEL triggered what came to be known as the Ippolito affair.

Indeed, CNEN general secretary was a member of the ENEL board. The assumed role of the nuclear power production in public utilities resulted in a press campaign. In August 1963, under the government of Christian Democrat Giovanni Leone, the Social Democratic Party's (PSDI's) leader Giuseppe Saragat attacked the management of CNEN run by Felice Ippolito to defend ENEL's top manager Arnaldo M. Angelini and Chairman Vito Di Cagno. Between August 10 and 17, the leader of the PSDI issued not less than five notes about CNEN, in which he savaged both the organization and its General Secretary, Ippolito. He expressed his concern that Ippolito, who also sat on the ENEL board, wanted to impose the same style of management on the new electricity company as he had done with the nuclear organization. The notes reveal that Ippolito was probably Saragat's target right from the beginning, because of his attacks on an ENEL board member (this could only have been Ippolito), and at the same time his defense of Di Cagno and, most notably, Angelini, who had been at loggerheads with Ippolito since 1959.

The story received prominent coverage on August 11 in the Italian business confederation's newspaper 24 *Ore* and in the main national newspaper *Corriere della Sera,* forcing supporters of Ippolito and of CNEN to make their own statements the following day in leftist newspapers (namely *Unità, Avanti!* and *Voce Repubblicana).* On August 13, the only daily newspaper in Italy that reported the spat without taking sides was the *Popolo,* the official organ of the Christian Democratic Party.

Saragat's notes set off a violent battle in the newspapers and in the political realm, which rapidly turned into a press witch hunt against Ippolito and CNEN. On August 18, Social Democrat Luigi Preti launched another attack on Ippolito, questioning whether he should continue in his post as general secretary of CNEN and director of ENEL. On August 20, in an interview with journalist Piero Ottone, Saragat explained that his criticism of the nuclear organization was not some silly season prank, but a clash between two competing approaches on the centre left in Italy: between people who, like himself, wanted to tackle what he called real problems, and people who were in his opinion far more interested in building power bases from which to take control over Italian life. On August 22, the Christian Democrat weekly Vita dedicated its cover to Saragat's criticisms, and re exhumed an attack on Ippolito from June by Bruno Ferretti, a member of the CNEN Executive Committee. Two days later, Italian Prime Minister Leone met with the Minister of Industry (who, by law, was chairman of CNEN) Giuseppe Togni, to look into the matter. On August 29, *Vita* offered prominent coverage of new leaks about the nuclear dossier before Leone, including, according to the weekly: the results of an investigation into CNEN carried out by a group of Christian Democrat senators led by Giovanni Spagnolli that July; Saragat's notes on CNEN's future program for which it was seeking financing through parliament; a note from the Public Accounts Office on the incompatibility of Ippolito's post at CNEN and his post at ENEL; and insinuations that not everything was above board in relations between the organization and a company to which the Ippolito family was allegedly connected. This last allegation was the one that caused Ippolito's defenders to stop and reassess their position. Indeed, many of them began to distance themselves from him, and drew a line between activities undertaken by the nuclear organization, and Ippolito's alleged personal responsibilities. On August 31, Togni suspended Ippolito as General Secretary and appointed a ministerial commission of inquiry. On September 6, the Rome attorney general asked to be kept informed of legally relevant developments concerning Ippolito, who had been named in the introduction to the decree of suspension published in the *Official Gazette,* and whose name had been mentioned in the papers. On September 13, Ippolito voluntarily went to see the attorney general, who took his deposition over the following four days. Four days later, the ENEL director's board submitted the issue of ineligibility to the electricity organization's supervisory authority, which on October 14 removed Ippolito from his post. Meanwhile, the issue reached Parliament in the form of questions and answers, including a proposal to launch a parliamentary inquiry, which was never properly considered. In the space of just a few weeks, Ippolito went from being a major power broker in Italy to a man in disgrace, savaged by anybody and everybody who thought that they had something to gain from his vulnerable position.

With Ippolito gone from CNEN and ENEL, it seemed that the men who supported the charges – Saragat and the former electricity company executives – had achieved their goal. The former electricity managers did not hide the fact that they had funded the press campaign against the now former general secretary of CNEN in order to make sure that he was not part of the industry's new structure. On March 3, 1964, after a number of months of investigation, Ippolito was arrested, and soon afterwards committed for trial. At the trial itself, the public prosecutor so explicitly harassed and intimidated the witnesses who testified in favour of Ippolito that he was roundly criticized in the foreign press and in some quarters of the Italian press too. At the end of the trial, which was followed very closely by the press, Ippolito was sentenced to eleven years in jail. Left leaning newspapers came out in favour of Ippolito, while right leaning newspapers were against him. Politically nonaligned newspapers remained more or less neutral after initially taking sides; the same was true of the Christian Democrat party's official organ. All newspapers disapproved of the severity of the sentence, with the *Corriere della* Sera leading the way. Subsequently, the Court of Appeal drastically downgraded the charges against Ippolito and found him guilty merely of much more minor irregularities. When Ippolito was freed from prison in 1968, he may have lost a position of great power, but neither his character nor his ideas had changed. He continued to defend the heritage of everything he had done, and he continued to support nuclear development. Among other things, he put a great deal of effort into disseminating scientific culture – a cultural and political battle that saw him taking on the role of editor in chief of the monthly magazine *Le Scienze,* the Italian edition of *Scientific American*, which he founded and produced himself.

Event 3: The nationalization of electric power intersects with the nuclear debate

The nationalization of electric power marked a crucial period for Italian nuclear programs. The power reactors went critical, while a program of expansion of nuclear power plants was in discussion in ENEL. But it was also during these years that Italian promoters of nuclear power experienced the first limits on nuclear power growth. The costs of the safeguards system, the opposition of oil companies

Figure 5 The imprisonment of the CNEN's chair, Felice Ippolito (in the middle), marked a watershed in the Italian history. On trial wasn't just the chair, but the whole design of State intervention in the nuclear power production. After the judgement of the leftist Ippolito, the scandals became part of the Italian political interplay.

to an alternative form of power production, as well as the technological limits of some types of reactors were global dynamics that affected nuclear development in Italy more than in other countries. The institutional weakness of nuclear authorities, following the Ippolito trial, led to nuclear power being more and more sidelined, although the Italian reactors were demonstrating quite good performance. This implied the oil share of power production grew up.

The start of construction work on three nuclear power stations in Italy was favourably received in the media and by public opinion, but as the whole issue was so tightly bound up with the overriding issue of electricity policy that disagreements were never far away. Criticisms were levelled at the size of the investment needed to build the power stations, the higher costs of nuclear generated electricity, the location of publicly owned power stations (both of which were in Southern Italy, and too close together at that), the lack of appropriate regulations and monitoring of the electro nuclear industry (this criticism was raised by those who were in favour of nationalizing the Edison power station), and the lack of overall coordination between the various initiatives. In truth, none of these criticisms was wholly groundless. However, in all cases, those targeted by these criticisms offered staunch (if not always convincing) defenses.

In 1958, when Amintore Fanfani opened the third legislature with a speech on the government's plans that reinvigorated the political debate on nationalization, the talk was of setting up a sole National Energy Body (Ente Nazionale per l'Energia, or ENE) by extending ENI's sphere of competence. This approach, which Mattei had been espousing since 1956, was probably the underlying reason for the foundation of AGIP Nucleare and the SIMEA, which were established as a means of getting one foot into the electricity industry via the nuclear industry. The original plan was quickly shot down not just by the private electricity enterprises and the so called economic right, but because of staunch opposition from the IRI, whose Finelettrica company, with Angelini at the helm, already had control over a significant portion of the Italian electricity industry. IRI was willing to form a joint venture with the oil company, but it was not prepared to be supplanted by it. Mattei's death by a suspicious plane crash in 1962 removed one of the most vociferous participants from the final phase of the nationalization debate. There were at that time two conflicting approach for the same task of nationalizing the electric power industry. The first one consisted in IRI acquisition of the existing private electric power companies, which kept their corporate structure but with the state as majority shareholder. The second one consisted in setting up a state run electricity organization which would expropriate the private companies and compensate their owners (through so called electricity compensation payments).

Each of these approaches had a different set of potential repercussions on Italy's future economic power structure. The first approach, championed by Christian Democrat economist Pasquale Saraceno, a leading expert on the problems of Southern Italy and a leading proponent of state run industry in the post war years, had the advantages of lower cost, of respecting minority shareholders' rights, and of leveraging the sound economic and managerial performance of IRI, which it had demonstrated through the public takeover of Italy's telephone industry by its subsidiary STET. The second approach was more favourably received by the major private enterprise groups – and not just the electricity companies – because the compensatory payments would generate new economic resources and open up new scope for private enterprise: many private concerns at that time in Italy felt targeted and suffocated by state run ventures. This second alternative was supported by a convergence of interests ranging from the rightist economic players to left wing parties worried about a further increase in the IRI's power, because the Christian Democrat Party influenced IRI. In the end, the second approach won the day. Nationalization was undertaken by founding ENEL, which was subsequently rwesponsible for the electricity compensation payments. This was a cost intensive solution which had significant impacts on the new organization's access to funds and its industrial strategies. From a technical point of view, Finelettrica took control of ENEL, and Finelettrica's chairman, Angelini, for many years served as the state electricity organization's general manager, before becoming its chairman. This team, supplemented by leading engineers drawn from the private companies, was responsible for two of ENEL's greatest achievements: unifying Italy's electricity system and completing the national grid.

The nuclear question, however, remained unresolved. Nationalization was the only move that could get a law on the peaceful use of nuclear energy through Parliament (Law number 1860, December 1962), after various bills had languished in Parliament over the course of two legislatures. The new law clarified CNEN's role and duties about industry issues ranging from applied and basic research (the latter of which was mainly carried out by the INFN) to facility inspections. Together, the two laws (on nationalization and the regulation of peaceful nuclear use) clarified the main aspects of the relationship between the nuclear body and the electricity organization with regard to the development of nuclear energy. Alongside its duty to promote, direct and fund applied research into reactors and all activities associated with the development of this new source of energy, CNEN was also responsible for monitoring plant security, assessing plant design, and ruling on plant locations. CNEN's Security and Protection Management Office (Direzione Sicurezza e Protezione, or the DISP) consequently took on a particularly important role, before CNEN was ultimately supplanted by today's National Agency for Environmental Protection. ENEL was put in charge of developing nuclear power within the framework of the national electricity system. This responsibility entailed decision making on power station construction, entering into agreements with contractors and fuel suppliers, and managing operations. In addition to drawing on in house resources, ENEL had access to proprietary industrial research facilities, including CISE, which the electricity organization had taken over as part of the nationalization process.

The real issue in the nuclear debate, both before and after nationalization, was whether or not nuclear energy could be competitive over the medium term, and what kind of role it would play in catering to the country's energy needs. Part of the controversy surrounding Ippolito in the summer of 1963 revolved around this very issue. At the start of the 1960s, nobody had any realistic idea of what the cost of nuclear power might be, though this situation was destined to change. In the meantime, private enterprise (and Vittorio De Biasi, CISE's first chairman) claimed that though it was necessary to engage in industrial scale experimental nuclear generation of electricity, it was not economically feasible to take on the enormous financial commitments required to build new plants. Ippolito, on the contrary, believed that a large scale and long term nuclear commitment (which, in Italy, seemed to be only within the scope of the public sector) would have ended up making nuclear energy cheaper than traditional thermoelectric energy, which is why he thought it was wrong to proceed so cautiously. This was yet another reason why Ippolito's removal was a negative sign for those who hoped that nuclear energy would undergo rapid development in Italy, and was a relief for oil companies.

The Ippolito issue was considered by many to be emblematic of a crisis that swept through state institutions as a whole, and had extremely serious repercussions across Italian scientific research. However, the most direct repercussions of the whole business were, not surprisingly, on energy policy. Nationalization of the electricity industry and CNEN's plans created a climate of expectation amongst industry professionals, who believed that civil nuclear use would develop quickly and broadly across the country.

Though they often took opposing views on economic strategies and institutional roles, the electricity industry and the nuclear organization represented two sides of the same coin. Both sides – as became evident in later years when CNEN was directed by Salvetti and ENEL run by Angelini – backed one another up. The negative repercussions of the weakened CNEN that emerged from the Ippolito case were only partially offset by Angelini's ENEL. The electricity organization was itself hamstrung by financial difficulties that were exacerbated by the economic crisis that struck in the 1970s. As a result of this, the development of Italy's nuclear industry suffered a marked slowdown just at the time that other European countries were boosting their output of nuclear generated electricity and using this fuel source to cater – finally – to a significant proportion of their energy demand.

The nationalization of a nuclear complex

Once work on the plants had been completed and they were up and running, all of the power stations that had been ordered prior to nationalization were handed over to ENEL. The necessary decrees were published in October 1963 (Latina), December 1964 (Garigliano), and January 1965 (Trino). Actual transfer to ENEL, however, required another year, and took place in December 1964 for Latina, and January and February 1966 respectively for Garigliano and Trino. Altogether, the capacity of these three power stations exceeded 600 MW; in 1965 they generated a total of 3.5 billion kWh, corresponding to 4.2 % of all electricity generated in Italy that year. In September 1964, when the new Geneva Conference opened its doors, Italy sat down at the table as the world's number three electronuclear power generator, after the US and UK. It is worth noting that Italy's three power stations were built within a reasonable length of time (around five years), kept to schedule, and came in on budget – three things that were never achieved again.

The commercial phase of nuclear power station construction officially began after phase three of the prototype research and development came to an end in 1963, when contractors (first General Electric, then Westinghouse) began to sell "turnkey" nuclear power stations at a fixed price. This was the point at which ENEL became a nuclear player. Despite the fact that it could leverage the experience acquired with the "first generation" plants, it had to operate in a structurally different nuclear market, and face a whole new set of social and political challenges. The many obstacles that the Trino power station had had to overcome in many ways anticipated the difficulties – not all of which were either technical or inevitable – which would beset Italy's future nuclear development.

Between 1963 and 1965, the approach to nuclear power in Italy was somewhat schizophrenic, what with the startup of the country's first reactors, their transfer to ENEL, and CNEN's responsibility for supervision, requests, and authorization for operation. During this same period, Ippolito was being fired and sent for trial, and CNEN's responsibilities were being curtailed by a technical committee led by Mario Silvestri, resulting in the closure of a number of programs that Silvestri had opposed in previous years. Things improved from there, with a "white paper" on nuclear power issued by Minister of Industry Giuseppe Medici, and Carlo Salvetti's appointment as deputy chairman of CNEN. Meanwhile, Angelini and his staff were getting to grips with organizing ENEL's central and geographical structure, and merging together legacy assets from the former Finelettrica companies and the former private electricity generating firms. The new organization had a number of pressing issues to deal with, most notably unification, standardization, and completion of the national grid. On the nuclear power front, ENEL had taken on not just the power stations but highly trained specialist human resources who were more than capable of running what was already in operation.

As far as industrial development was concerned, major advances were underway in the US. Technological progress and a significant boost to the power output of individual nuclear units, without a major increase in the (still large) capital requirements, promised economies of scale that were especially impressive for water reactors, and marked an important step towards economic competitiveness. Moreover, now that US companies were offering nuclear reactors at much lower prices, there was an increasing belief that the product was now mature, and the market outlook for the new technology was improving. Last but not least, the boom in orders for electricity power stations in the US following the 1966 New York blackout led, the following year, to thirty nuclear power stations being commissioned. Lombardi noted that these events had a widespread echo on the situation in Italy, where strong growth in energy consumption had made the nation increasingly dependent on oil imports. Electricity consumption was also affected, as hydroelectric power was no longer sufficient to cover demand. In 1966, Salvetti and Angelini independently and on multiple occasions announced that a major nuclear power station building program was on the cards.

By the end of the 1960s, it was clear that loading the organization with the responsibility for paying electricity compensation fees, failing to provide it with an endowment fund, and failing to embark upon an overhaul of pricing had a consequence: The failure to develop what, in other industrialized nations, was considered the energy source of the future. This was the outcome of political decisions, and had nothing to do with the desires of ENEL or CNEN management. ENEL admirably acquitted all of its statutory duties. Indeed, it was precisely for this reason that after placing an order for the fourth power station, the organization could do little more than lobby the political authorities. At every opportunity, ENEL championed a nuclear program as the only feasible solution to the country's energy and electricity demand issues. For as long as he was at the helm of ENEL, and indeed beyond that, Angelini fought his corner hard. Commentators of the day and a number of historians opposed the idea of reprising the nuclear program, which, though justified in terms of demand, became unfeasible. However, in all likelihood the jury remained out on this topic for quite some time. In the spring of 1973, one decade after nationalization, Angelini took over from Di Cagno as ENEL chairman.

Event 4: The impact of the oil crisis on the Italian nuclear sector

In Italy, the 1973 oil crisis is often remembered for the drastic measures that were introduced that autumn and in the winter of 1974 to cap oil consumption. That year 1974, a confluence of negative events took place: for the first time since the war, the inflation rate hit double figures (12 %); the discount rate rose to 6.5 %, and the advance rate peaked at 9 %; in addition, a ceiling was imposed on bank lending to limit business access to credit. All this took place after a year (1972) in which all Western economies except Italy experienced economic recovery. For ENEL, 1973 was the year that Law no 253 guaranteed the organization of a 250 billion lire five year endowment fund. A price review was undertaken to enable the organization to conduct long term energy industry development, particularly in the nuclear sector, and the Italian state stepped in to guarantee bonds that the organization had issued. These measures – the endowment fund in particular – were too little, too late, certainly in terms of the size of investment required for the nuclear program, not to mention the then rate of inflation and higher borrowing costs. Because the expenses of one million kW nuclear power stations were high, it turned out that only to settle the difference of 300 billion lire, the amount was financially inadequate. The entire endowment fund was inadequate for the significant investments required every year to build the new nuclear power stations. Not only did past difficulties remain, but they also continued to worsen as time went on. The oil crisis persuaded the government to relaunch the nuclear program, and to empower ENEL to order new power stations. The national body in charge of steering the Italian economy was the Comitato Interministeriale per la Programmazione Economica (CIPE, Interministerial Committee for Economic Planning). The same document added that ENEL intended to order both one million kW power stations at a rate of two power stations per year until 1976.

At the beginning of 1974, ENEL had three nuclear power stations in operation and a fourth under construction, which had been ordered in 1970 (though the decision to build it had been taken back in 1967). In 1968, the organization decided to build a fifth power station, before the financial problems described above put the nuclear program on hold. In December 1971, ENEL resolved to initiate procedures prior to ordering a fifth power station. A call for tenders commenced in December 1972, along the lines of the Caorso power station procedure. Specifications were published that same month. Technical bids were received by ENEL in June 1973. After assessing the bids and seeking several changes, bidders were requested to submit their prices by November. The power station for which they were bidding was to have a power capacity of between 800 and 1,000 MW; the company reserved the right to order a second power station of the same specification within one year of choosing the winning bid. Clearly, this condition was intended to accelerate the tender process and reduce delays in ordering reactors.

When it came to drafting the tender specifications, ENEL ruled out gas technology, following a rethink in the British nuclear program, and France's decision to replace gas cooled reactors with Canadian style heavy water natural uranium reactors. ENEL called for tenders from Elettronucleare Italiana (a Westinghouse licensee) for a pressurized water reactor, AMN (a General Electric licensee) for a boiling water reactor, and the Atomic Energy of Canada Limited (AECL, affiliated with Italimpianti) for a CANDU type reactor (pressurized heavy water natural uranium). ENEL had already completed an initial survey of potential sites for future power stations, which were listed in a confidential memo dated February 1973. It was from this list that potential sites for the newly ordered power stations would be chosen.

In December 1973, after receiving assurances from the Italian government and the adoption of new legislation, ENEL decided to order not just a fifth but also a sixth nuclear power station. The organization was following – to the letter – Angelini's April 1972 proposal to order two power stations in 1973 and a further two in 1974. The ENEL director's board commissioned Italy's fifth and sixth nuclear power stations from Elettronucleare and AMN. Though AECL bid was not taken up, a deal was subsequently struck with the company for a smaller and different commission under the auspices of the CIRENE project. ENEL reserved the right to exercise an option to double the order from both winning bidders by the summer of 1974.

In the summer of 1974, orders were placed for Italy's seventh and eighth nuclear power stations, which were twins of the fifth and sixth power stations. In effect, the seventh and eighth power stations were new reactors that would be located on the same sites as their twin, in effect doubling the capacity of power stations number five and six. Plans for the fifth and sixth reactors at one point called for certain parts of the power stations and plant to be shared. The new power stations were due to be located in the Molise region (the fifth and seventh units) and in Upper Lazio (the sixth and eight units). In his 1974 report, the managing director warned to obtain site access as rapidly as possible, let say obtaining the necessary authorizations to begin construction, especially the building permits. Having at long last put its financial problems behind it, ENEL now had to tackle the issue of finding new locations. It should be said that this issue also applied to traditional thermoelectric plants, and to electricity power lines, but in the case of nuclear power stations, opposition tended to be particularly strong.

In August 1975, the government passed Law no. 393 to regulate localization procedures. The final paragraph of Article 2 called for robust intervention from central government, but as this portion of the law was never invoked, the measure did not end up making sites available. In 1975, after oil prices suffered a further hike, Minister of Industry Carlo Donat-Cattin drew up the government's national energy plan, which was approved by CIPE on December 23, 1975. Under this plan, the government pledged to start building new 1,000 MW nuclear power stations, drawing on experience that had been acquired and leveraging domestic and international programs underway at that time. The plan stated that Italy might have as many as 20 nuclear power stations in operation by 1985. The government also commissioned a parliamentary enquiry into energy, which was undertaken in autumn 1976 by the Chamber of Deputies' Industry Committee. The committee concluded with the unanimous adoption, on April 28, 1977, of a document confirming the government's focus on nuclear power stations. The government reiterated its intentions in a resolution approved with cross party support on October 5, 1977. The third government led by Christian Democrat Giulio Andreotti (which included the Italian Communist Party in the coalition) subsequently called for an immediate start to work on the power stations that had already been approved, and sought immediate preparation of a location plan. With all of this political backing, in 1977 ENEL sent out calls for submission of technical bids for the provision of a further eight 1,000 MW units. At the end of 1977, in acknowledgement of delays to the scheduled construction of power stations and difficulties in securing the necessary sites, CIPE adopted a revised energy plan on December 23, which retained the same overall objectives but reduced the target for 1985 to at least 6,000 MW of nuclear energy.

Atomic autonomy?

In 1973, a further Law (no. 856 of December 18) authorized ENEL to set up a joint venture with EDF of France and RWE of Germany to build and commercialize FBRs. CNEN had begun working on fast reactors under its Prova Elementi Combustibile (PEC, Fuel Element Testing), the goal of which was not to generate energy but to build a reactor for testing fuel for the first French commercial FBR, i.e., using fuel elements with characteristics that differed from thermal reactors. Angelini had personally been a proponent of a European wide joint venture in this field, bringing together public nuclear organizations and the private nuclear industry. Angelini was backed in these efforts by Salvetti, who had long supported this type of research. A trilateral European venture began to take shape in 1971 to build two fast reactors in France and Germany. ENEL's wishes to reap benefits in terms of electricity generation, industrial experience and orders; CNEN hoped to be able to complete its PEC program.

In 1974, ENEL acquired a 33 % share in the German company ESK, owner of the SNR 2 power station which was to be built in Germany, and in the French NERSA company, in which EDF had a controlling 51 % stake, and which was to oversee construction of the first fast reactor at Creys Malville: this was the future Superphénix reactor. This venture spawned major industrial agreements between Nucleare Italiana Reattori Avanzati (NIRA) and Novatome of France, to supply the nuclear boiler for the power station, and between NIRA and CEA to share the expertise developed through the fast reactor system. Further industrial agreements were struck between CEA and AGIP on fuel, and between French and Italian industrial companies regarding the supply of various nuclear block and refrigeration circuit components. CEA and CNEN also entered into research and development agreements. Construction work began on Superphénix in late 1976. The power station achieved criticality for the first time in September 1985, and went into commercial service in early 1986. Belgium, Holland and the United Kingdom subsequently signed up to these fast reactor related agreements.

One of the reasons why ENEL had been so interested in developing fast reactors was because of their potential with regard to CISE Reattore a Nebbia (CIRENE, CISE Mist Reactor) an Italian designed heavy water natural uranium reactor which CISE had been working on since 1957, in a project led by Silvestri. CISE had opted for this type of technology because of the particular history and circumstances of Italy's home grown reactor project, which had begun back in 1946. Though a complex technology, heavy water was scientifically and industrially feasible for Italy; a pilot plant for manufacturing heavy water was one of CISE's early achievements, even before CNEN had been established. Moreover, being able to fuel the reactor with natural uranium circumvented the political and technical issues associated with importing enriched uranium; manufacturing enriched uranium in Italy would have required technological, industrial and financial abilities that were beyond Italy's reach.

Silvestri and his team undertook a feasibility study for a reactor moderated using heavy water and cooled using natural boiling water. CIRENE was an original solution that adopted technology under development at that time not only in Italy but in Canada (which went on to sell this type of reactor under the name CANDU), Britain and Japan. Work continued on CIRENE after funding was secured from Euratom and CNEN, which had first expressed interest in the reactor when Ippolito was still in charge of the organization. In 1967, through Salvetti, CNEN struck a deal with ENEL to build a 40 MW prototype. In 1972, ENEL commissioned AMN to build a prototype of this technology in Latina, on the same site as SIMEA gas cooled power station. This commission was only completed in 1987.

Event 5: The road to the first referendum on nuclear energy

Criticisms of ENEL during the 1970s basically fell into two categories: On the one hand, the electricity organization was rebuked for an excessively prudent approach to the nuclear program in the 1960s, which led to Italy being worse off than the rest of Europe when the 1973 economic crisis struck and the country did not have sufficient nuclear electricity generating capacity to draw on. On the other hand, the organization was taken to task for development plans that failed to consider the shortcomings of Italy's industrial system, and the country's backward looking management practices.

ENEL shrugged off the first category of criticisms by saying that a prudent approach to nuclear programs in Italy had allowed the country to leverage the experience acquired by others in new reactor technologies. Curiously enough, the company did not defend itself by citing its economic difficulties; something that, in internal documents and the organization's annual report, it made abundantly clear was the main reason why Italy's nuclear program had fallen behind schedule. Understandably, no mention was made, either, of the blows that the ENEL and CNEN nuclear operations suffered between 1963 and 1967 owing to a series of events beyond their control, ranging from the Ippolito case to technical and organizational emergencies that ENEL was required to tackle immediately. Within the heated framework of Italy's energy debate, citing these reasons would have sounded like a *j'accuse* against the political authorities, and the electricity organization and its top managers depended precisely upon these political authorities.

This assertion was borne out by the facts. A 1978 Confindustria document confirmed that in 1977 and early 1978, Italian electro mechanics companies won more than 40 % of all international calls for tenders for electric power stations. The market, however, was increasingly shifting towards nuclear power stations, and Italian companies were in danger of losing their position because of insufficient domestic orders. As Ansaldo Chairman Ambrogio Puri pointed out in a letter to Angelini in March 1976, Italian industry could manufacture all of the components of a nuclear power station, and could actively manage licenses, but it could not develop specific nuclear power plant systems experience without in the field experience. As competitors gained more and more experience on their home turf, Italy was losing its technological competitiveness. After the dust had settled on the clashes that marred the 1960s, by the early 1970s Italy's nuclear industry had acquired a lasting configuration in which ENI's Fabbricazioni Nucleari (Nuclear Fabrications) focused on fuel related provisioning, and IRI's Finmeccanica (AMN) was responsible for building plants under license from General Electric. Both of the nuclear power stations that had been ordered used American licensed light water technology; one license was held by Elettronucleare Italiana, the consortium that had built the Trino power station, before becoming a supplier to ENEL. By the late 1970s, the IRI's leadership in the industry was uncontested, and it had proceeded to set up joint ventures with private companies, particularly with FIAT. The real bottleneck in implementation of the nuclear plan regarded the siting of the power stations, which was not part of ENEL's responsibilities. The issue was also not specifically Italian. If this had been the case, then it would have been impossible to build any of the three first generation power stations, as well as the Caorso plant. Chroniclers pointed their finger at the paradoxical behavior of Italy's political parties. At the central government level, ENEL's nuclear program had broad cross party support, but at the local level, party activists were bitterly opposed to the prospect of a plant being built in their area. Central government never had the appetite to invoke the authoritative procedures enshrined in the 1975 law. Evidently, the issue was not sufficiently important to risk a showdown with local party potentates. It was this issue, and insufficiently strong political backing, that in the second half of the 1970s led to ENEL's nuclear program finally grinding to a halt. Edison first experienced local opposition when it wanted to locate its Westinghouse power station in the municipality of Moneglia, near Genoa. The problem was quickly resolved when the town of Trino Vercellese offered land to the company, and perhaps because of this, people underestimated the importance of the issue. Difficulties were also encountered in Caorso, though these ended up being resolved; indeed, here the problems were related more than anything else to an earlier dispute over the nearby Isola Serafini hydroelectric power station. However, before starting site work, AMN hired a specialist advisor to investigate potential social and local unrest and perceptions of the power station. Far stronger opposition was encountered during the selection of sites in the Molise region for the fifth and seventh units. Here, local government held out for particularly expensive infrastructure commitments in exchange for giving their OK. In the end, CIPE was advised not to proceed. ENEL was consequently forced to relocate the two units to Lombardy and Piedmont, only for the regional administration in these two areas to wage their own rearguard defense. The regional government in Lazio, however, offered ENEL a site at Pian dei Gangani, near Montalto di Castro. However, local and regional political backing was insufficient to counter the opposition of local people, who kept up permanent protests which significantly slowed down work on the power station. Safety checks by the DISP did not seem to reassure the locals about the minimal risks they ran; local people did not view the organization as independent.

ENEL countered the problem by running a concerted nuclear information campaign, which reached its peak between 1976 and 1981. However, by the end of the 1970s, it had become clear that out of the four power stations ordered under ENEL's nuclear program, only the Montalto site had any realistic chance of being completed. By the late 1970s, the international climate was increasingly unfavourable to Italy's nuclear plans. The events that took place in the 1980s are well documented. In 1981, the government issued a revised national energy plan calling for three new 2,000 MW power stations to be built in Piedmont, Lombardy and Puglia. The plan was the first to introduce the standard plant concept. Dubbed Progetto Unificato Nucleare (PUN, Unified Nuclear Plan), the plan was based on Westinghouse pressurized water technology, and allocated responsibilities as follows: ENEL was the commissioning party and systems architect; ENEA (founded in 1982, to take over from CNEN) was the monitoring authority; AGIP Nucleare was the fuel supplier; and Italy's private nuclear companies, through a consortium led by AMN (which was named the main contractor), were to supply plant systems and components.

A turning point: growing protests and the referendum

Public attitudes toward nuclear power changed dramatically during the 1980s. When the nuclear industry experienced the first big accident at the Three Mile Island power plant concern about the safety of the plants started to grow in the local communities where the Italian reactors were, or were supposed to be, located. The turning point was the Euro missiles crisis, when the Communist party, the largest party on the Italian left, endorsed the peace movement's demands. Because of a certain overlap between the peace movement and antinuclear movement, ecologists and extreme left militants found common ground in protests. They called for a referendum on nuclear power, as well as a moratorium on the Euro missiles. When the Communist party shifted toward antinuclear positions, the opponents of nuclear power won the referendum. While the referendum did not automatically entail shutting down the existing plants – but only certain seminal features of the plan to expand nuclear power – its effects were magnified by the political parties renouncing any present or future use of nuclear power. This concluded the Italian nuclear programs, also affecting research in the nuclear sciences.

In 1976, an environmental impact study was presented in respect to the location of the nuclear reactor at Montalto di Castro, which would lead to its construction being authorized three years later. In 1977, Donat-Cattin, still Ministry of Industry, issued an ultimatum to the regions, asking them to indicate potential sites for the construction of 20 nuclear plants. Thus, the government allowed local public opinion to be heard, located close to possible nuclear sites, and this permitted a shift in public opinion as a whole. Indeed, the meantime strong protests were growing, from local populations, committees, environmentalist associations, some minority political forces, and even local administrations. Large demonstrations took part at Montalto di Castro, Viadana, Suzzara and San Benedetto Po (in Lombardy, when it was proposed to locate some nuclear plants there), involving a very visible part of the local populations living near the nuclear sites, even if they did not represent the majority of these populations; the organizations World Wildlife Fund and Italia Nostra also produced documents and organized meetings. The Lombardy Region appointed a commission to study nuclear plants, and requested advice from the Istituto Superiore di Sanità (ISS, National Institute of Health). A bipartisan front arose, based at the local level, in the populations living near some plant sites. However, the majority of the political forces and unions were strongly in favour of nuclear energy, including the majority of the Communist Party and the left wing Union CGIL. In any case, in response to these movements the political debate grew: the parliamentary commission of Industry held a fact finding inquiry, and there was a parliamentary debate on the topic.

However, a second national energy plan was approved by the Interministerial Committee for Economic Planning CIPE in December 1977, providing for the immediate construction of 12–13 nuclear plants, leaving the remaining eight until after 1985. In response to this, popular protests and demonstrations continued to grow – the more so when on February 19, 1979, Romano Prodi, Ministry of Industry in the fourth Andreotti government, authorized the construction of the plant in Montalto di Castro. This occurred just before the Three Mile Island accident on March 28, 1979. During the same period, the movie *China Syndrome*, with Jane Fonda, came out. In the meantime, in August 1978, the Garigliano plant had been shut down after several accidents. In the USA, following the Three Mile Island accident, two commissions were appointed (headed respectively by John G. Kemeney, the President of Dartmouth College, and Mitchell Rogovin, of the Nuclear Regulatory Commission), each producing a report which invited the nuclear utilities to radically change their safety regulations, and proposed to authorize the nuclear plants at a greater distance from residential areas, to provide emergency safety plans approved by a federal agency, and to provide for the evacuation of the population in case of accidents to a radius of 30–40 km. Both the reports circulated in Italy, offering support to the antinuclear ecologist movements.

In Italy, on the institutional side, in June 1979 the results of a fact finding special ecological commission from the Senate garnered favourable opinions from many, but not from the ecological associations WWF and Italia Nostra. In December, the new Ministry of Industry, Bisaglia, appointed a committee on nuclear safety, which approved a document with the relevant opposition, and a minority report, from the three environmentalist representatives, denouncing the deficiency of the Italian safety rules compared to international ones. The national energy plan (PEN) was successively revised in 1980 and 1981, providing for the construction of nuclear plants of at least 6,000 MW (indicating potential sites in the Regions of Piedmont, Lombardy, Veneto, Tuscany, Campania, Puglia, and Sicily), with a Piano Nucleare Unificato (PUN, Unified Nuclear Plan) based on the Westinghouse PWR reactor, ostensibly contradicting the previous choice of the Caorso BWR plant from General Electric. It is worth noting that in these same years, Italy had reduced its participation in the Eurodif enrichment plant from 25 % to 16.5 %, and was obliged to sell some of the enriched uranium it had already acquired at a loss, following the downsizing of its nuclear project. In the meantime, in 1982 CNEN acquired the new name of Ente Nazionale per l'Energia Nucleare e le Energie Alternative (ENEA, National Agency for Research and Development of Nuclear Energy and Alternative Energies), with a few changes, including a new research section on renewable energies: an alternative choice, since the new 1985 PEN confirmed 12,000 MW of nuclear energy.

In the years 1981–1983, hostility towards nuclear energy grew further, as several municipalities expressed their opposition. A law in 1983 provided for economic incentives to those municipalities which had accepted nuclear and thermoelectric plants on their territory; in addition to nuclear power, coal-fueled plants were also being pushed by the various national energy plans. ENEA expressed its positive opinion regarding the suitability of the sites at Viadana and San Benedetto Po, and ENEL began the geological tests. Anti-nuclear demonstrations, fights with police, and arrests followed. Two municipal popular referendums were held in Viadana (1984) and in San Benedetto Po (1985) in the province of Mantua, Lombardy, and opposition to the nuclear plants won out in both cases. In 1985 there was a big demonstration in Rome in which the protest against the deployment of cruise missiles in Comiso, Sicily, merged with the local delegates' protests against the siting of nuclear islands.

Just one month before the Chernobyl accident, the situation changed rapidly. On March 20, 1986 CIPE approved the 4th PEN, providing only for the construction of the 2,000 MW plant at Montalto di Castro, plus 2,000 MW more at Trino Vercellese, in Piedmont (never begun), and the siting of two more 2,000 MW plants, in Lombardy and Puglia respectively, by 1986; in addition, as recalled, it provided for the acquisition of 400 MW from the 1,2000 MW fast reactor Superphénix, under construction in France.

The Communist Party held its 17th congress on April 9–13, 1986 in Florence, in which an antinuclear motion was presented and attracted many votes. Two weeks later, on April 26, 1986, the Chernobyl accident happened. It made a deep impression, and caused great concern regarding the behavior of the Chernobyl cloud; public debate and polemic was thus revived. Local and national demonstrations (Rome, May 10) proliferated. In July the gathering of signatures for a national referendum began. In October, after a huge demonstration at Montalto di Castro, the Bettino Craxi (Italian Socialist Party) cabinet decided to halt the nuclear reactors construction plans, and called for a major conference on energy, which was held in February 1987, without any significant result. The execution of the referendum, on November 8–9, 1987, was the beginning of the end of Italian nuclear power. Promoted by the Radical Party, the referendum abrogated: CIPE's prerogative to decide on the location of nuclear plants, when the interested municipalities were not able to decide; the compensation available for municipalities which hosted nuclear or coal plants; and the possibility for ENEL to participate in international nuclear programs, such as FBR. 65 % of citizens who had the right to do so voted in the referendum. On the first question, 80.57 % of votes were in favour; on the second question, it was 79.70 %; and on the third question, 71.90 %.

Facts & Figures

The purpose of this section is to give an overview of nuclear power in Italy. This section contains such data as the number of reactors, the locations of reactors, technical and chronological details of reactors' construction, as well as statistics on electricity production, periodization, and social connections to nuclear constructions.

Data summary

- Italy had three power reactors (in Latina, Trino Vercellese and Caorso sites) operating at the time of the Chernobyl accident, but their production stopped between 1986 and 1987.
- There were plans to build four new reactors (i.e. two BWR units at Montalto di Castro, and two PWR units at Trino) but this project was cancelled.
- Italy is the only G8 country that has no nuclear power plants; however, Italy imports about 10 % of its electricity from nuclear power sources.
- Italy was active in the building and planning of new nuclear plants in the past, despite the antinuclear movements that were widespread in Europe in 1970s.

Key dates and abbreviations

Key dates

1952	National Committee for Nuclear Research (CNRN) founded
1958	Construction of the first nuclear reactor for the production of energy
1959	Construction of the second nuclear reactor
1960	CNRN became the National Committee for Nuclear Energy (CNEN, now the ENEA)
1961	Construction of the third nuclear reactor
1962	Nationalization of the electricity sector and founding of ENEL
1964	Latina NPP acquired by ENEL
1965	Trino and Garigliano NPP acquired by ENEL
1966	ENEL plans to have 12,000 MWe of NPP installed by 1980
1967	CNEN and ENEL begin developing their own nuclear heavy water reactor with light water cooling, CIRENE (Italian version of the CANDU reactor)

1969	Enel orders the fourth power plant for Italy from GE/Ansaldo
1970s	Antinuclear movements
1972	Start of construction of the CIRENE reactor at Latina, which is never finished and never becomes operational
1974	Partnership with France and Germany to develop FBR
1981	New energy plan contains three new nuclear power plants with two units each and 1,000 MWe each, with technology from Westinghouse
1982	Start of construction of Montalto di Castro NPP with two units, but the project is delayed because of local opposition
1986	New energy plan calling for increase of capacity of nuclear power plants, one month before the Chernobyl accident
1987	National Conference on Energy positive about continuation of nuclear power developments
1987	Referendum in November, after which government decided to cancel nuclear power projects
1987	Latina NPP closed in December
1990	Decision to shut down Caorso and Enrico Fermi NPPs
1999	State owned company SOGIN founded in order to decommission nuclear facilities in Italy and allocate the waste
2004	Energy law passed allowing electricity imports from foreign nuclear power companies
2007	Public opinion, based on 800 respondents, showed that 83 % were against nuclear power in Italy
2008	Government plans to return to nuclear power and to build new NPPs
2008	Public opinion poll, based on 800 respondents, showed that 54 % were in favour of nuclear power in Italy
2009	Official government legislation passed aiming to generate 25 % of Italian electricity from domestic nuclear power by 2030
2010	Legislation and framework developed regarding the siting of nuclear power plants with agreement from local governments
2010	Strong local opposition against nuclear power; bids to the Constitutional Court
2010	Eurobarometer survey on nuclear power in Italy shows that 62 % of respondents are for decreasing the nuclear energy share
2011	Constitutional Court decided to conduct a public referendum on nuclear power in Italy, which results in strong opposition to all the proposals put forward by Mr. Berlusconi and the plan to have 25 % of Italy's electricity from nuclear by 2030

2011 Government decides to postpone nuclear power construction for one year after the Fukushima accident

Abbreviations

AGIP General Italian Oil Company (Azienda Generale Italiana Petroli) with the nuclear branch AGIP Nucleare
AMN Ansaldo Nuclear Machinery (Ansaldo Meccanico Nucleare)
CEA Atomic Energy Commission (Commissariat à l'Energie Atomique)
CIPE Interministerial Committee for Economic Planning Programming (Comitato Interministeriale di Programmazione Economica)
CISE Centre for Information, Studies and Experience (Centro Informazioni Studi Esperienze)
CIRENE CISE Mist Reactor (CISE Reattore a Nebbia)
CNEN National Committee for Nuclear Energy (Comitato Nazionale Energia Nucleare)
CNRN National Committee for Nuclear Research (Comitato Nazionale Ricerche Nucleari)
EDF Electricity of France (Electricité de France)
ENEA National Committee for Nuclear Energy (Ente Nazionale Energia Nucleare) then National Committee for Research and Development of Nuclear Energy and Alternative Energies (Ente Nazionale per la Ricerca e lo Sviluppo dell’Energia Nucleare e delle Energie Alternative), then National Agency for New Technologies, Energy and Sustainable Development (Agenzia Nazionale per le Nuove Tecnologie, l’Energia e lo Sviluppo Sostenibile)
ENEL National Agency for Electricity (Ente Nazionale per l'Energia Elettrica)
ENI National Hydrocarbons Authority (Ente Nazionale Idrocarburi)
ENSI Southern Italy Nuclear Energy (Energia nucleare sud Italia)
ESK European Fast Breeder Nuclear Power Plant (Europäisches Schnell-Brüter Kernkraftwerk, ESK)
ESSOR ORGEL tests (Essai ORGEL)
FIAT Italian Automobiles Factory, Turin (Fabbrica Italiana Automobili Torino)
FBR Fast Breeder Reactor
GAAA Atlantic Alsatian Atomic Group (Groupement Atomique Alsacienne Atlantique
IRI Institute for Industrial Reconstruction (Istituto Per La Ricostruzione Industriale)
ISS National Institute of Health (Istituto Superiore di Sanità)

MWe	Megawatt electrical
NER	European Fast Neutrons Group (Groupement Nucleaire Européenne à Neutrons Rapides)
NPP	Nuclear Power Plant
NUCLIT	Italian Nuclear (Nucleare Italiana)
ORGEL	Organic Heavy Water (Organique Eau Lourde)
PEC	Fuel Element Testing (Prova Elementi Combustibile)
PEN	National Energy Plan (Piano Energetico Nazionale)
PUN	Unified Nuclear Plan (Piano Nucleare Unificato)
PRO	Organic Reactor Project (Progetto Reattore Organico)
PCUT	Uranium Thorium Cycle Program (Programma Ciclo Uranio Torio)
RWE	Rhine Westphalian Electricity (Rheinisch-Westfälisches Elektrizitätswerk)
SADE	Adriatic Electric Company (Società Adriatica di Elettricità)
SBK	Fast Breeder Nuclear Power Plant Company (Schnell-Brüter Kernkraftwerksgesellschaft mbH)
SELNI	Italian Electronuclear Society (Società Elettronucleare Italiana)
SENN	National Electronuclear Society (Società Elettronucleare Nazionale)
SIMEA	Southern Italian Society for Atomic Energy (Società Italiana Meridionale per l'Energia Atomica)
SOGIN	Nuclear Plant Management Company (Società Gestione Impianti Nucleari)
SORIN	Nuclear Plant Research Company (Società Ricerche Impianti Nucleari)
WNA	World Nuclear Association
WWF	World Wildlife Fund

Map of nuclear power plants

Map 1 represents a map of nuclear power plant sites in Italy

Source: public domain

List of reactors and technical, chronological details

Tables below show the list of reactors, suppliers, operators as well as relevant dates.

Table 1 Operational and projected commercial nuclear power reactors in Italy

No	Name	Operator	Supplier	Type	MWe net	A	B	C	Status
1	**Caorso**	SOGIN	GE/Ansaldo	BWR	860	1970	1978	1990	P.S.
2	**Enrico Fermi**	SOGIN	Westinghouse	PWR	260	1961	1964	1990	P.S.
3	**Garigliano**	SOGIN	General Electric	BWR	150	1959	1964	1982	P.S.
4	**Latina**	SOGIN	Magnox	GCR	153	1958	1963	1987	P.S.
5	**Montalto di Castro 1&2**	–	–	BWR	982	1982	–	–	Canc.

Sources: IAEA 2019, WNA 2016

A Start of reactor's building, B Connection to the power grid,
C Date of shutdown, P.S. Permanent shutdown, Canc. Cancelled

Overview of statistics on electricity production

A general overview of the data on the energy sector in Italy is available on the OECD website.[1] The following chart shows a recap of the main indicators contained in the Energy Statistics of the OECD countries for the period 2010–2014.

	2010	2011	2012	2013	2014
Primary Energy Supply					
Total, Toe/1000 US dollars	0.100	0.098	0.097	0.095	0.090
Crude Oil Production					
Total, Thousand toe	5079.03	5282.99	5395.97	5500.95	5762.90
Electricity Generation					
Total, Gigawatt hours	290,747	291,441	287,802	278,833	–
Renewable Energy					
Total, Thousand toe	169,992	166,893	161,311	155,372	146,227
Nuclear Power Plants					
Total, Number	0	0	0	0	0
Crude Oil Import Prices					
Total, US dollars/barrel	79.3	110.2	112.2	110.0	99.1

The data presented in this chapter were collected in the first instance by the Italian Autorità Per Il Sistema Elettrico Il Gas E Il Sistema Idrico (Italian Regulatory Authority for Electricity, Gas and Water) and published in their 2016 annual report, disclosed for the first time on June 21, 2016 at the Italian Chamber of Deputies in Rome.[2] The Italian Regulatory Authority for Electricity, Gas and Water is the independent body which regulates controls and monitors the electricity and gas markets in Italy. It was established by law on November 14, 1995, no. 481, with the purpose of protecting the interests of users and consumers, promoting competition and ensuring efficient, cost effective and profitable nationwide services with satisfactory quality levels.

1 OECD (2016), Primary energy supply (indicator). doi: 10.1787/1b33c15a-en, accessed June, 30, 2016.

2 Autorità di Regolazione per l'Energia e l'Ambiente, relazione 2016 http://www.autorita.energia.it/itrelaz_ann/16/16.htm, accessed August, 14, 2019.

The Authority's mission includes defining and maintaining a reliable and transparent tariff system, reconciling the economic goals of operators with general social objectives, and promoting environmental protection and the efficient use of energy. It provides an advisory and reporting service to the government and parliament, and formulates observations and recommendations concerning issues in the regulated sectors of electricity and gas.

Energetic National Balance Sheet 2014–2015 (Mtep)

2015	Solids	Gas	Oil	Renewables	Electric Energy	Total
1 **Production**	0.30	5.55	5.47	31.41	–	**42.72**
2 **Import**	13.19	50.12	81.28	1.86	11.18	**157.64**
3 **Export**	0.26	0.18	27.04	0.11	0.98	**28.57**
4 **Variation Reserves**	– 0.22	0.19	0.50	0.03	0.00	**0.50**
5 **Available for Internal Consumption** (1+2+3–4)	13.46	55.30	59.21	33.13	10.20	**171.29**
6 **Consumption Losses in Energy Sector**	– 0.11	– 1.61	– 3.62	– 0.01	– 41.28	**– 46.64**
7 **Transformation in Electric Energy**	– 10.61	– 17.11	– 2.23	– 25.64	55.59	**–**
8 **Total Final Use** (5+6+7)	2.73	36.58	53.35	7.48	24.50	**124.65**
– Industry	2.68	11.47	3.95	0.03	9.31	**27.44**
– Transport	–	0.90	36.73	1.15	0.91	**39.69**
– Civil Uses	0.00	23.50	3.01	6.29	13.82	**46.62**
– Agriculture	–	0.14	2.14	0.01	0.47	**2.75**
– Non Energetic Uses	0.06	0.57	4.95	–	–	**5.57**
– Storage	–	–	2.58	–	–	**2.58**

Energetic National Balance Sheet 2014–2015 (Mtep)

2014	Solids	Gas	Oil	Renewables	Electric Energy	Total
1 Production	0.35	5.86	5.77	32.61	–	**44.58**
2 Import	13.46	45.67	71.19	2.22	10.28	**142.83**
3 Export	0.24	0.19	20.31	0.14	0.67	**21.55**
4 Variation Reserves	– 0.12	0.62	–	– 0.63	0.02	**– 0.11**
5 Available for Internal Consumption (1+2+3– 4)	13.69	50.71	57.27	34.67	9.62	**165.97**
6 Consumption Losses in Energy Sector	– 0.12	– 1.68	– 3.55	– 0.01	– 40.84	**– 46.20**
7 Transformation in Electric Energy	– 10.65	– 14.65	– 2.34	– 27.79	55.43	**–**
8 Total Final Use (5+6+7)	2.93	34.39	51.38	6.87	24.21	**119.77**
– Industry	2.85	11.87	3.98	0.03	9.20	**27.93**
– Transport	–	0.86	35.33	1.03	0.90	**38.12**
– Civil Uses	0.00	21.02	2.94	5.80	13.65	**43.42**
– Agriculture	–	0.12	2.13	0.01	0.46	**2.71**
– Non Energetic Uses	0.08	0.51	4.71	0.00	–	**5.30**
– Storage	–	–	2.29	–	–	**2.29**

Sources	2011	2012	2013	2014	2015
Thermoelectrical Production	**217,674**	**205,075**	**175,897**	**157,439**	**171,108**
Solids	44,726	49,141	45,104	43,455	43,600
Natural Gas	144,539	129,058	109,876	93,637	107,600
Petroleum Products	8474	7023	5418	4764	4700
Others	19,935	19,852	16,499	15,583	15,208
Pumped Hydroelectrical	1934	1979	1898	1711	1369
Renewable Energy Sources	**82,962**	**92,222**	**112,008**	**120,679**	**109,561**
Hydroelectrical	45,823	41,875	52,773	58,545	43,894
Aeolian	9856	13,407	14,897	15,178	14,676
Photovoltaic	10,796	18,862	21,589	22,306	25,206
Geothermal	5654	5592	5650	5916	6181
Biomass	10,832	12,487	17,090	18,732	19,604
TOTAL PRODUCTION	**302,570**	**299,276**	**289,803**	**279,829**	**282,038**

References

Books, articles, papers

Battimelli, Giovanni., 2003. *L'eredità di Fermi. Storia fotografica dal 1927 al 1959 dagli archivi di Edoardo Amaldi.* Rome: Editori Riuniti.

Battimelli, Giovanni, De Maria, Michelangelo, and Giovanni Paoloni, eds. 2001. *L'Istituto Nazionale di Fisica Nucleare. Storia di una comunità di ricerca 1945–1975.* Rome-Bari: Laterza.

Bini, Elisabetta, and Igor Londero, eds. 2017. *Nuclear Italy: an International history of Italy's Nuclear policies during the Cold War.* Trieste: EUT.

Castronovo, Valerio. 2012. *Il gioco delle parti. La nazionalizzazione dell'energia elettrica in Italia.* Milano: RCS Libri.

——, ed. 2012. *Storia dell'IRI (1933-1948). 1. Dalle origini al dopoguerra.* Rome-Bari: Laterza.

——, ed. 2002. *Storia dell'Ansaldo, vol. 8. Una grande industria elettromeccanica.* Rome-Bari: Laterza.

——, ed. 1994. *Storia dell'industria elettrica, vol. 4, Dal dopoguerra alla nazionalizzazione 1945–1962.* Rome-Bari: Laterza.

Colitti, Marcello. 1979. *Energia e sviluppo in Italia. La vicenda di Enrico Mattei,* Bari: De Donato.

Curli, Barbara. 2002. "Il Nucleare." In *Storia dell'Ansaldo, vol.8. Una grande industria elettromeccanica,* ed. by Valerio Castronovo, 109–142. Rome-Bari: Laterza.

——. 2000. *Il progetto nucleare italiano. Conversazioni con Felice Ippolito (1952–1964).* Soveria Mannelli: Rubbettino.

De Angeli, Sergio, Mariarosa Borroni and Andrea Locatelli. 1996. "La gestione aziendale." In *Ricerca, innovazione, impresa. Storia del CISE: 1946-1996,* ed. by Sergio Zaninelli, 89–156. Rome-Bari: Laterza.

De Paoli, Luigi, and Giovanni Paoloni. 2012. *I cinquant'anni di ENEL.* Rome-Bari: Laterza.

——.1994. "Programmi di investimento e novità tecniche." In *Storia dell'industria elettrica, vol. 4, Dal dopoguerra alla nazionalizzazione 1945–1962,* ed. by Valerio Castronovo, 163–238. Rome-Bari: Laterza.

Elli, Mauro. 2011. *Atomi per l'Italia: la vicenda politica, industriale e tecnologica della centrale nucleare ENI di Latina (1956–1972).* Milan: Edizioni Unicopli.

Geiss, Friedrich. 2011. *Where Science Meets Politics. The Eventful History of the EU's Joint Research Centre.* Public domain: ebook Edition.

Gerlini, Matteo. 2017. "Energy Independences vs. Nuclear Safeguards: the US attitude toward the European Fast Breeders Reactors Program." In *Nuclear Italy: an International history of Italy's Nuclear policies during the Cold War,* ed. by Elisabetta Bini and Igor Londero, 141–150. Trieste: EUT.

——. 2012. "Public Opinion Strikes Back." In *The Circulation of Science and Technology: Proceedings of the 4th International Conference of the ESHS.* Barcelona: SCHCT-IEC.

Ippolito, Felice, and Folco Simen. 1974. *La questione energetica. Dieci anni perduti 1963/1973.* Milan: Feltrinelli.

Lombardi, Carlo. 1994. "La questione dell'energia nucleare." In *Storia dell'industria elettrica in Italia, vol. 5, Gli sviluppi dell'ENEL.* 1963–1990, ed. by Giovanni Zanetti, 589–644. Rome-Bari: Laterza.

Maiocchi, Roberto. 1996. "Il ruolo della ricerca." In *Ricerca, innovazione, impresa. Storia del CISE: 1946-1996,* ed. by Sergio Zaninelli, 43–88. Laterza: Rome-Bari.

Nau, Henry R. 1972. "The practice of interdependence in the research and development sector: fast reactor cooperation in Western Europe". In *International Organization* 26 (3), 499–526.

Nuti, Leopoldo. 2007. *La sfida nucleare. La politica estera italiana e le armi atomiche.* Bologna: Il Mulino.

Paoloni, Giovanni. 2009. *Il nucleare in Italia. Nuclear Power in Italy.* Rome: Archivio storico ENEL.

——, ed. 1992. *Energia, ambiente, innovazione: dal CNRN all'ENEA.* Rome-Bari: Laterza.
Rigano, Anna Rita. 2002. "La banca d'Italia e il progetto ENSI". In *Quaderni di storia economica*, no 4. Roma: Banca d'Italia, Ufficio ricerche storiche.
Silvestri, Mario. 1968. *Il costo della menzogna. Italia nucleare 1945–1968.* Turin: Einaudi.
Zanetti, Giovanni, ed. 1994. *Storia dell'industria elettrica in Italia, vol. 5, Gli sviluppi dell'ENEL. 1963–1990.* Rome-Bari: Laterza.
Zaninelli, Sergio, ed. 1996. *Ricerca, innovazione, impresa. Storia del CISE: 1946–1996.* Rome-Bari: Laterza.

Published primary sources

IAEA Country Nuclear Power Profiles. 2019. Accessed 20 June 2019. https://cnpp.iaea.org/countryprofiles/Italy/Italy.htm
Parliamentary Records, Senato della Repubblica, Legislature V, Doc. XVIII, no 1.
Parliamentary Records, Camera dei deputati, Legislature V, Doc. XV, no 37–1968.
World Nuclear Association. 2018. *Nuclear Power in Italy.* Accessed 16 April 2018. https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/italy.aspx.

Arne Kaijser

The Referendum that Preserved Nuclear Power and Five Other Critical Events in the History of Nuclear Power in Sweden

Executive Summary

This chapter focuses on the history of the relations between nuclear energy and society in Sweden. The first section gives an historical overview of Sweden's nuclear history. An ambitious research programme on nuclear energy began after World War II with both civilian and military goals. In the mid-1950s this led to a decision to build a domestic nuclear fuel cycle based on heavy water reactors (HWRs), partly to enable the construction of nuclear weapons, which became a contested issue. Ten years later private power companies started ordering a number of light water reactors (LWRs), because they thought these reactors would be more economical, and the plans for a domestic fuel cycle were abandoned. In the early 1970s a strong nuclear industrial complex had arisen.

At this time, an anti-nuclear movement emerged which quickly grew in size. Two of the five parties in Parliament took an anti-nuclear stance, and after the elections in 1976 the leader of one of these became the new Prime Minister. In the following years nuclear issues were very high on the political agenda. In 1980, partly in response to the accident at Three Mile Island (TMI), an advisory referendum on nuclear power was organized. The referendum campaign engaged hundreds of thousands of activists. The outcome was a defeat for the anti-nuclear side. Parliament decided to continue nuclear expansion in the short run, but to slowly get rid of all nuclear power by the year 2010. In the 1980s Sweden became the country with most nuclear power per capita in the world, and it still is. A full phase out did not occur. However, in 1999 and 2005 the reactors in Barsebäck, very close to Copenhagen, were phased out, in 2015 one reactor was phased out in Oskarshamn and three more reactors (one in Oskarshamn and two in Ringhals) will be phased out by 2020.

The issue of waste disposal has been much disputed since the 1970s. In the early 1980s a number of attempts to drill in order to find a place for a repository were strongly opposed by local environmental groups. In the 1990s, SKB, the organization responsible for the nuclear waste, changed strategy, seeking coopera-

tion with local municipalities. Two municipalities that already had nuclear plants were identified as suitable locations for a repository and a competition emerged between them for hosting it.

The second and third chapters analyse a number of events when nuclear issues were intensively debated and contested in order to illustrate the relations between the nuclear industry and civil society in Sweden. The events are

– the nuclear weapons controversy
– public inquiries on energy futures in the 1970s
– the referendum on nuclear power in 1980
– local protests against a repository
– Chernobyl and its political effects in Sweden
– a competition for getting a repository.

For each event, the actors involved, the arguments used, and the kind of public engagement are discussed.

Historical Context

Introduction to the historical context

During almost three decades after World War II, Sweden experienced fast economic growth. Sweden had managed to keep its neutrality during the war and its industry was intact. The Social Democratic Party governed the country until 1976 and strived for fast economic growth in order to build a welfare society. A fast urbanization took place. In 1949 Sweden decided to remain neutral and not to join NATO as its close neighbours Norway and Denmark did. This decision was combined with an ambitious strengthening of the Armed Forces.

Energy was an important issue. Sweden has very limited fossil resources, and the country's dependency on energy imports had become very salient during the war when Sweden had had to import coal from Nazi Germany in exchange for iron ore. After the war, there was a strong will to develop domestic energy sources. The hydro power resources in northern Sweden were exploited and this power could be transmitted to southern Sweden through new high voltage lines built by the ASEA company, which became a world leader in high voltage technology in the 1950s. Sweden had large uranium resources and the option of developing nuclear energy became a very attractive future possibility. This would also enable the development of nuclear weapons and there were strong advocates for such weapons, but also critics. There was a broad political support in the post-war decades for a very ambitious nuclear programme, financed by the government. This programme led to the building of several research and experimental reactors in the 1950s and commercial reactors in the 1960s and onwards.

In the mid-1970s, a fast economic growth came to an end partly due to the Oil Crisis and the international economic recession following it. Moreover, the long Social Democratic hegemony came to an end in 1976, when a right-centre coalition won the elections and formed a government. Energy became a vital political question anew. The Oil Crisis had demonstrated Sweden's huge dependency on oil; imported oil provided no less than 75 % of total energy supply. An environmental opposition had emerged and questioned the further exploitation of hydropower in northern Sweden and highlighted the impact of the acidification of the environment caused by large scale use of fossil fuels. Moreover, the safety of nuclear power plants that were becoming operational was being questioned by some scientists and environmentalists. In fact, ever since the mid-1970s, nuclear power has been a central controversy in Swedish politics; it has been decisive for the outcomes of Parliamentary elections, it has toppled governments and it has been the issue of a referendum. This chapter focuses on the debates and conflicts around nuclear power. First a general narrative is presented, followed by a presentation of the main actors. In the subsequent chapters a number of illustrative events will be analysed.

Contextual narrative

Coordinated military-civilian nuclear research, 1945–1955

The atomic bombs over Hiroshima and Nagasaki were the starting point of Swedish activities in the field of nuclear energy. The military and some scientists (primarily physicists and chemists) were the first to act: for the military, it was naturally of vital importance to get information about this new, extremely powerful weapon and its implications for future warfare. For the scientists, there was an element of scientific inquisitiveness and a prospect for future funding (Lindström 1991, Larsson 1987). Both groups lobbied for action, and in November 1945 the Government appointed an Atomic Commission, with the task of investigating the need for research. The commission consisted of very prestigious scientists, two who were Nobel laureates (Manne Siegbahn and The Svedberg) and two future laurates (Arne Tiselius and Hannes Alfvén), as well as high ranking public officials. In its report the commission recommended, firstly, to strengthen basic research in relevant fields of physics and chemistry at universities and research institutes, and, secondly, to establish a special organization, the Atomic Energy Company (AE), with the task of developing reactor technology (Lindström, 1991).

These recommendations were readily adopted by the Social Democratic government; a bold effort, orchestrated by the state, to use the results of science for the well-being of society and which therefore suited their ideological beliefs very well. In particular, Tage Erlander, Prime Minister from 1946 to 1968, had a strong interest based on personal contacts with leading physicists, including Niels Bohr. An Atomic Energy Company was set up in 1948 and its first major task was to build a small research reactor called R1, a 100 kW heavy water reactor (HWR) fuelled with natural uranium. The choice of location of R1 may seem rather remarkable today; it was on the campus of the Royal Institute of Technology, only a few kilometres from the centre of Stockholm. However, the reactor was built in an excavated cave in the rock 20 meters below the ground. On July 13, 1954, the reactor was completed and heavy water was pumped into the reactor tank. When the reactor went critical, Sweden had definitively entered the nuclear age (Lindström 1991, Larsson 1981).

The nuclear research also had a military dimension. After World War II, Sweden started to build up a strong military defence. This effort was intensified when Sweden in 1949 decided not to join NATO but to remain non-aligned. A large domestic arms industry was developed and in particular the aircraft industry had a pivotal role; in fact, Sweden's Air Force became the fourth largest in the world in the 1950s. The National Defence Research Institute (FOA) established in 1945 was given a crucial role for research and technological development in the military field. One of the new institute's first actions was to secretly set up a research group on nuclear weapons led by the young nuclear physicist Sigvard Eklund (Agrell 2002, Jonter 2016).

In 1950 Eklund was recruited to AE as research director and was given the responsibility for building the R1 reactor. He was also – more secretly – responsible for coordinating the civilian and military nuclear research. He proposed that the future "civilian" reactors should be heavy water reactors fuelled by domestically mined natural uranium. Moreover, they should be constructed in such a way that weapons-grade plutonium could be produced. Finally, reprocessing plants should be built to separate this plutonium from the spent fuel. In 1953 Eklund wrote a report in which he outlined a plan for the construction of ten bombs of Nagasaki-strength within ten years (Agrell 2002).

Up to the mid-1950s there was almost unanimous political support for the nuclear research programme. However, the commercialization of nuclear energy still seemed uncertain and far away, and therefore the power companies and the electrical equipment industries were rather passive.

The Swedish Path and the atomic weapons controversy, 1955–1965

US President Dwight Eisenhower's launching of the Atoms for Peace policy in late 1953, and in particular the first Geneva Conference on Atomic Energy in August 1955, raised expectations for nuclear energy in a dramatic way. The new international policy implied a change from utmost secrecy to a considerable openness in nuclear matters. Both the Swedish general public and the power industry were filled with optimism about a coming commercialization of the new technology. In late 1955 the government appointed a new Atomic Commission to formulate a long-term policy in the nuclear field. This commission outlined a very ambitious programme, which came to be known as the Swedish Path. It was adopted by Parliament the following year (SOU 1956:11).

The long-term goal of this programme was the development of a domestic nuclear fuel cycle, encompassing the extraction of the vast (but low-grade) Swedish uranium resources, the construction of heavy water reactors for producing heat and electricity and the reprocessing of the spent fuel. This goal has to be seen in its historical context. Sweden has hardly any fossil resources, and during both World Wars, imports of coal and oil had been drastically reduced, causing severe problems for both industry and households. Swedish dependence on foreign energy supplies increased after World War II owing to a rapid rise in oil consumption. The resulting vulnerability was underlined during the disturbances in the global fuel markets caused by the Korean War. Increased self-sufficiency of energy supply was thus seen as a vital goal and in this context the domestic uranium deposits were seen as a crucial resource, even though the uranium percentage in these deposits was known to be low. The Swedish Path also had a less overt military aspect. A domestic nuclear fuel cycle was not only a way of diminishing dependence on foreign energy supplies, but also a way of enabling the production of material necessary for the construction of nuclear weapons (Lindström 1991, Agrell 2002).

The parliamentary decision in 1956 about the Swedish Path meant that huge resources were channelled to the nuclear domain in general and the Atomic Energy Company in particular. The staff of the Company increased rapidly from 260 employees in 1956 to 1000 in 1959, and more than 1500 in 1964. In the second half of the 1950s AE built a research facility in Studsvik with two research reactors. Moreover, it built two heavy water reactors for energy production, first a combined heat and power producing reactor and later on a larger power-producing reactor. The first pilot reactor was built in a rock cavern in Ågesta, just south of Stockholm. It took three years longer and cost five times more to build this plant than it was originally estimated, but in 1964 the plant was completed and put into operation and produced 55 MW heat for district heating and 10 MW electricity. The second reactor was to be built in Marviken, near the city of Norrköping. The further history of this reactor is a story of time- and cost-overruns, of growing criticism both from technical experts and from politicians, and of refusal to relinquish the project because of prestige. Finally, even the management of AE had to admit that the plant did not fulfil the necessary safety requirements and the project was brought to an end in May 1970 (Schagerholm 1993, Glete 1983, Brynielsson 1989).

AE also worked with the other links of the nuclear cycle. In the early 1960s, facilities for uranium mining were built in Ranstad, east of Gothenburg. In 1965 the production capacity was tested but only on a small scale; at this time uranium could be imported for a price that was 40% lower than the production costs in Ranstad. Research was also conducted in the reprocessing field, but it was concluded that a reprocessing plant would be too costly.

In the late 1950s a strong controversy arose concerning nuclear weapons both within the governing Social Democratic Party and outside it. Growing factions within the governing party, not least its Women's Association, wanted to put a halt to the development of nuclear weapons. Also, the government itself was divided on the issue with the Defence Minister supporting nuclear weapons while the Foreign Minister opposed them. The controversy threatened to cause a major disruption in the party and Prime Minister Tage Erlander set up a study group to investigate the matter and try to find a compromise. After more than a year of discussions, the study group presented a report recommending FOA to stop the construction of weapons but to pursue what they called "extended protective research" (Agrell 2002).

In 1958 twenty leading intellectuals including the Archbishop and some well-known authors and academics established Aktionsgruppen mot Svensk Atombomb (the Action Group against Swedish Atomic Weapons), AMSA. AMSA had a programme with two points: opposing that nuclear weapons were introduced to the Swedish defence and supporting that the financial resources saved were used for development aid instead. The members of AMSA were very active and influential; they wrote articles in newspapers, participated in radio and TV debates, talked at public meetings etc. In April 1960, they made a plea for a referendum on nuclear weapons, and started to gather signatures for their plea, but were not able to muster the necessary number of signatures. When this campaign failed, AMSA more or less dissolved (Agrell 2002).

The following year a new organization called Kampanjen mot Atomvapen (Campaign against Atomic Weapons) was established inspired by the British organization Campaign for Nuclear Disarmament and the Danish Kampagnen mod Atomvåpen. Like these organizations it strived for different kinds of members and other types of activities than AMSA had done. KMA attracted young people, not least students, and focused on organizing marches and protests. The first major event was a 2-day-long protest march from central Stockholm to FOA's research facility in September 1961 with 800 participants. The following years similar protest marches were arranged with several thousand participants (Agrell 1999). However, the issue of constructing Swedish nuclear weapons lost its political urgency in the early 1960s, when leading militaries changed their views on the benefit of nuclear weapons. Sweden gradually changed its foreign policy and took an active part in the international negotiations concerning the Non-Proliferation Treaty. In 1968 Sweden formally decided not to develop atomic weapons and to sign the Non-Proliferation Treaty. The debate on nuclear weapons is analysed in event 1.

Building the first LWR plants without public debate, 1965–1972

In the mid-1960s the prospects for the Swedish Path had changed due to the decreased importance of the military aspects of the programme, and the choice of reactor type was discussed at length among Swedish energy experts in particular among utilities and the leading electric manufacturer, ASEA. The Swedish power industry was made up of the State Power Board, called Vattenfall, which produced about 40 % of all power and a dozen private power companies (many owned by municipalities and/or energy-intensive industries). For the power industry the national independence aspect of nuclear reactors was subordinate to their competitiveness and reliability. In the late 1950s many power companies started to question the HWR – which was an integral part of the Swedish Path – from a commercial point of view. They were influenced by the fact that the major US electric equipment producers were developing LWRs of two kinds; General Electric was building Boiling Water Reactors (BWR) and Westinghouse Pressurised Water Reactors (PWR). By then it was possible to buy enriched uranium from the United States, which made such LWRs a possible alternative.

When, in December 1963, General Electric signed a turn-key contract for a 520 MW reactor to be built in Oyster Creek for the sensationally low price of 68 million US dollars (equivalent to 350 million Swedish crowns), this was seen as definite proof of the economic superiority of LWRs. In retrospect it is clear that General Electric sold this plant far below the actual costs, assuming that rapidly falling costs would compensate for the sale of one or more loss leaders. The optimism and enthusiasm resulting from the Oyster Creek plant were decisive in the establishment of a consortium of private power producers called Atomkraftkonsortiet, AKK, later renamed Oskarshamns Kraftgrupp AB, OKG, which in 1964 started negotiations with ASEA for the construction of a large BWR at Oskarshamn. In July 1965, a contract for this plant was signed. The total investment cost for this 440 MW plant was 500 million crowns (Jasper 1990).

ASEA was the leading Swedish supplier of electric technology. In 1952, it had built the world's first 400 kV high voltage line in close cooperation with the State Power Board, Vattenfall. As early as 1954 ASEA formulated a long-term strategy for its nuclear energy activities. Its goal was to become an internationally competitive producer of nuclear reactors. ASEA saw itself as the leading Swedish force in the development of commercial reactors. However, the launching of the Swedish Path in 1956 made it clear that the government wanted AE to play the leading role in the development of a domestic nuclear construction capacity, with ASEA being one of several suppliers. ASEA vigorously opposed this division of responsibility. It argued that AE lacked the competence necessary for the design of commercial nuclear plants. Yet, in the late 1950s and early 1960s, it was AE that had the financial power through its generous government funding. ASEA could not afford to finance the necessary development on its own, and thus became dependent upon orders from AE. ASEA built most of the Ågesta plant and the Marviken plant, and even though these reactors were not LWRs, the building of them made it possible for ASEA gradually to build up more and more competence in the nuclear field. By 1960 ASEA's nuclear division had grown to 350 people (Glete 1983).

At this time ASEA became more pessimistic about the future for nuclear energy. The economic prospects seemed gloomier with decreasing oil prices and increasing construction costs for nuclear plants (specifically the Ågesta reactor). The company also started to question whether the HWR was the best choice of reactor, and it studied several other reactors including a graphite-moderated gas-cooled reactor of the British type and a light-water boiling reactor developed in the United States. In 1964, after the spectacular Oyster Creek contract, the AKK (later OKG) started negotiations with ASEA about a large BWR of about 300-400 MW in Oskarshamn. For ASEA this would mean a big step; the Ågesta reactor was much smaller and of a different type, and ASEA did not even have experience with conventional thermal plants of this size. ASEA thus started negotiations with General Electric about a license-agreement. But ASEA found the conditions imposed by General Electric too restrictive and chose to develop its own reactor. This was a bold move since all other European companies chose to buy US licenses. Nevertheless was ASEA confident of its own ability, and the fact that AE proved to be very willing to cooperate with ASEA was of considerable importance (Glete 1983).

The contract signed with the Oskarshamn-consortium in July 1965 was thus a decisive, but risky, step for ASEA. Soon after this contract Vattenfall and the largest private power company, Sydkraft, showed interest in additional reactors. However, ASEA met competition from a consortium of Swedish industries and Westinghouse. Vattenfall too was convinced of the superiority of LWRs after Oyster Creek. But it was uncertain whether BWRs or PWRs were the best solution. Furthermore, in the middle of the 1960s Vattenfall was somewhat doubtful about ASEA's capacity to design and build commercial reactors. ASEA had little previous experience with large thermal plants, and Vattenfall was not fully satisfied with an oil-fired plant that ASEA was building for it at this time. For ASEA Vattenfall was a customer of the utmost importance. In 1968 the Swedish government used this situation to almost extort ASEA into a merger with AE; it was clearly indicated that ASEA would not get Vattenfall's order if it did not comply. And soon after the merger the new company, ASEA-Atom, got a contract for one of the two reactors that Vattenfall ordered for the Ringhals plant the other was a PWR from Westinghouse.

In the following five years, ASEA-Atom got seven new reactor orders, two from the Forsmark-consortium with Vattenfall as the dominant party, three from the private Swedish power industry and two from the Finnish power consortium, TVO. ASEA's 1954 long-term goal of becoming an internationally competitive producer of nuclear power plants now seemed to have been achieved, even though it had been forced to merge with its rival, AE. It was a remarkable technological achievement for ASEA; all the other companies that managed to become independent producers of reactor plants – Westinghouse, General Electric, and Siemens (KWU) – were much larger firms, devoting more personnel and financial resources to nuclear development (Jasper 1990).

On May 18, 1972, the nuclear power plant in Oskarshamn was inaugurated by the King of Sweden, Gustav VI Adolf, with the following words:

> Nuclear power is a proof of man's ability to develop his surroundings. In an ever-increasing pace it has come to stand out as the rescue out of a feared energy crisis. In a time when the epoch of hydropower development is coming to a close and difficulties are being discerned regarding the supplies of fossil fuels nuclear power has been realized. Sweden's first commercial power plant thus marks the beginning of a new epoch in our country's energy supply. The completion of this nuclear power plant is a milestone in our country's industrial development. Swedish industry has with foresight and skillfulness independently developed a technology of which we today can see the application. The Oskarshamn power plant represents a technical achievement which well matches the great innovations in Swedish industry. (Gimstedt 1990).

The inauguration was a moment of great pride for all participants and the future for nuclear power looked very bright indeed. The participants made up what could be called a "nuclear-industrial complex" encompassing ASEA-Atom, Vattenfall and the private power companies, government and government agencies and technical universities. This complex planned to build 24 plants in the coming decades and the prospects for exporting nuclear technology were also promising. Neither the King nor any of the prominent guests could anticipate that nuclear power would very soon be strongly contested in Sweden.

Nuclear power contested 1973–1978

Nuclear energy had long been considered a clean, environmentally benign source of energy. In the 1950s and 1960s, the largest and oldest environmental organization, Svenska Naturskyddsföreningen, SNF, had even demanded a faster introduction of nuclear power to save the remaining wild rivers from being exploited for hydro power (Lindström 1991). Thus, very little questioning of nuclear power occurred in Sweden until the early 1970s, but from 1972 and onwards a dramatic shift took place and nuclear power became heavily criticized by many different kinds of actors. Three of these were particularly important: scientists, politicians and environmental activists.

The single person that most strongly contributed to this shift was a scientist, Hannes Alfvén. He had been awarded the Nobel Prize in physics in 1970 and thus was held in high regard as researcher. He had also been deeply involved in the nuclear research programme as board member of the Atomic Energy Company. In the late 1960s he did much of his research in California and came in contact with the growing number of American scientists and engineers who began to question the safety of nuclear power plants, the difficulties of taking care of the radioactive waste from reactors, and the risk of proliferation of nuclear weapons materials. Alfvén became increasingly critical of nuclear power and started writing articles in newspapers and contacting politicians. He even wanted to give a speech at the first UN conference on the human environment organized in Stockholm in June 1972, but was not given the opportunity. Alfvén soon became a very influential nuclear critic as his knowledge and insight could not easily be questioned. Also, a number of other Swedish scientists and nuclear experts were influenced by the critique formulated by Alfvén and colleagues abroad, but as many of them worked (directly or indirectly) for the Swedish nuclear industry they were hesitant to formulate their critique publicly (Anshelm 2000, Jasper 1990).

Secondly, a number of parliamentarians began to question nuclear power, some from the Centre Party, which was at the time the second largest party after the Social Democrats and some from the Communist Party. In the spring of 1973 they succeeded to get approval in parliament for a proposal that investigations about the risks of nuclear power had to be made before any decisions about new nuclear power plants were made. One of the parliamentarians also arranged a meeting between Hannes Alfvén and the party leader of the Centre Party, Thorbjörn Fälldin. Fälldin was deeply impressed by Alfvén and became a dedicated opponent of nuclear power, and soon the entire party took an antinuclear stance, which fitted well with the party's new environmental ideology. The party had traditionally been the political representative of the farmers, but with a fast decreasing population in the countryside, the party tried to attract urban voters with a green policy of environmentalism and decentralism (Anshelm 2000, Lindqvist 1997).

A third category of nuclear critics were young environmental activists. In the late 1960s a new kind of environmental movement emerged, consisting of small and often local activist groups inspired by similar movements abroad. They protested against polluting industries, car traffic, acid rain and other issues. In the early 1970s they found out that their sister organizations in the United States were increasingly questioning nuclear power and realizing the huge scale of the Swedish nuclear programme they started to learn about the criticism against nuclear power and disseminated it. However, this environmental movement was rather scattered in many small organizations and was as yet unable to organize a broad protest movement against nuclear power (Interviews Daleus, Odell, Kågeson and Falk).

The growing criticism of nuclear power among scientists, politicians and environmental activists led to an intensive public debate. Many critical articles were published in large daily newspapers, the first critical books were published (Kågeson 1973) and environmental groups distributed many pamphlets and posters. The growing antinuclear sentiments, together with the oil crisis in 1973–1974, put energy policy at the centre of the political arena. Several government commissions were appointed to study different aspects of energy such as nuclear waste treatment, research and development needs in the energy sector, and long-term prospects for the energy sector. In 1975 an Energy Bill was passed, which initiated an ambitious research and development programme, ranging from nuclear research to renewable energy sources and energy efficiency (Prop. 1975, 30). Furthermore, this Bill foresaw a reduction in the future growth rate of energy demand and thus a smaller expansion of nuclear energy than previously expected. A total of 13 nuclear reactors were envisaged by 1990, compared to 24 reactors a few years earlier.

In 1976, for the first time in 40 years, the non-socialist parties won over the Social Democrats in the parliamentary elections, and Fälldin became Prime Minister in a coalition government. At the end of the election campaign, Fälldin had made very clear antinuclear statements on ethical grounds, and this was probably decisive for the victory, which was very close (Holmberg et al. 1977). However, the other two non-socialist parties in the government coalition had a very different, much more positive, view of nuclear energy, and the nuclear issue caused much conflict. One way to handle this was to set up a government commission with representatives from the different parties and organizations involved for trying to find compromises. This commission made a very detailed investigation and outlined four scenarios for the future but could not unite in a joint vision (SOU 1978, 17). The role of all the government commissions in the second half of the 1970s will be analysed in event 2 below.

Nuclear waste was an issue that attracted particular attention in the public debate, and in the spring of 1977 the government proposed a Nuclear Stipulation Act which was passed by Parliament. This Act stipulated that reactor owners had to demonstrate that they would be able to handle the spent fuel from their reactors in a "totally safe" way to get permission to commission new reactors. This Act spurred the Swedish power companies to jointly pursue an intensive research project about a methodology for final storage of spent fuel; alternatively of the high-level waste produced if the fuel was reprocessed. However, despite this effort to find a common ground, the government split in 1978, after a confrontation about how to interpret the Nuclear Stipulation Act, and a minority government led by the Liberal Party was formed with Carl Tham as Energy Minister (Vedung 1979).

TMI and the referendum on nuclear power

The environmental movement in Sweden grew in strength during the 1970s and it increasingly focused on nuclear power. In 1978 a broad umbrella organization called Folkkampanjen mot Atomkraft, the People's Campaign against Atomic Power, was established. There was a lively debate within the People's Campaign about possible strategies. How would it be possible to fight the powerful nuclear industrial complex that moreover was supported by three political parties with an overwhelming majority in Parliament? A referendum emerged as the best option. However, when the People's Campaign demanded a referendum, the nuclear friendly parties opposed it arguing that the nuclear issue was too complex for a referendum (Eriksson 1981, Interviews Daleus, Odell, Kågeson and Falk).

So, the People's Campaign started a petition for a referendum in the beginning of March 1979, and activists began to collect signatures. In the midst of this campaign, the Three Miles Island accident occurred on March 28. Swedish mass media reported extensively about it, and the accident gave the anti-nuclear movement an enormous boost (Holmberg and Asp 1984). A week later, Olof Palme announced that the Social Democrats had changed stance and now supported a referendum, and the Conservatives and Liberals soon followed suit.

The approval of the referendum was a huge success for the People's Campaign. But the framing of the referendum, which was decided by Parliament, became a disappointment. The anti-nuclear side had foreseen a straight forward referendum with two alternatives, one for a phase-out and one for a continued expansion of nuclear power. It came as a shock to them when the pro nuclear parties split into two alternatives instead of one, for tactical reasons (Eriksson 1981, Interviews Daleus, Odell and Kågeson, Falk). Thus Line 1 was supported by the Conservatives, Line 2 by the Social Democrats and the Liberals and Line 3 by the Centre Party, the Communists and, of course, the People's Campaign.

Line 3 was a straight forward phasing out alternative and meant that the six operating nuclear reactors should be phased out within ten years. Line 1 and Line 2 were almost identical, and they too were framed as phase out alternatives, albeit in a far future. The crucial formulation in both was as follows: "Nuclear power will be phased out at a pace that is possible with consideration to the need for electricity for employment and welfare" (Holmberg and Asp 1984, 95). Concretely the two lines proposed that besides the six reactors already in operation, six more reactors already completed or under construction should be brought into use in the coming years. The only difference between the two alternatives was that Line 2 in addition demanded public ownership of all nuclear power plants. Line 2 was intended to appear as a "middle way" alternative and their slogan was "phasing out, but with reason" (Holmberg and Asp 1984, 90).

The referendum campaign dominated political life and the mass media for several months. The Line 3 campaign became a mass movement of grassroots activists all over Sweden. They organized demonstrations, public meetings, distributed campaign newspapers, and knocked doors to talk with ordinary people. The campaigns of the other two lines were more like ordinary election campaigns, dominated by party officials and professional lobbyists and were heavily supported by Swedish industry economically. They had the resources to finance huge ads in the major newspapers (Holmberg and Asp 1984).

The outcome of the referendum was that Line 2 received 39.1% of the votes, Line 3 received 38.7% and Line 1 received 18.9%. Based on the referendum, Parliament set up the goal that all nuclear power plants should be phased out by the year 2010. But in the short term it meant a return to "business as usual". In the following five years six additional reactors, much bigger than the previous ones, were taken into operation. The outcome was of course a huge disappointment for all the members of the People's Campaign that had campaigned so intensively in the previous months. Not surprisingly an overwhelming majority of the activists became disillusioned and quit the People's Campaign. A few joined political parties instead, not least the new Green Party that was founded in 1981 (Eriksson 1981, Interviews Daleus, Odell, Kågeson and Falk). The referendum on nuclear power represents the peak of nuclear debate in Sweden when hundreds of thousands of Swedes were actively engaged, and it will be analysed further in the next chapter as a showcase of interaction between nuclear industry, political parties and civil society in Sweden.

Nuclear expansion and nuclear waste

A few weeks after the referendum, the government approved fuel loading for the four reactors that were completed but not yet operating. Later on, the companies received about 4 billion crowns from the state as compensation for the delay of commissioning owing to the referendum. Furthermore, the construction of two additional, even bigger reactors was accelerated. These were completed and taken into commercial operation in 1985. Consequently, nuclear power production increased threefold from the time of the referendum to 1985, and Sweden now generated more nuclear power per capita than any other country.

Electricity consumption did not develop according to earlier forecasts in the 1980s and in order to find a market for all this additional power, Vattenfall reduced its electricity prices considerably in 1983, and the other power producers followed suit. About half of the new electricity was used for the heating of houses, and this was criticised by the nuclear opponents as a wasteful way of using electricity. For ASEA-Atom the completion of the 11th and 12th reactors in Sweden marked the end of an epoch. Since then the company has built no more reactors. Not only the Swedish market but also the international market for nuclear reactors almost vanished in the late 1970s, and the company did not get any new reactor orders after 1976. However, the nuclear fuel manufacturing division, now owned by Westinghouse, is very competitive in the international market.

Nuclear waste was another issue that had to be dealt with by power companies and government. In 1979 the power companies had presented a methodology for final storage of spent fuel in accordance with the Stipulation Act. This method, called KBS, was approved by the regulating agency SKI, and this was a condition for the commissioning of the new reactors. As a next step the power companies owning nuclear reactors had to try to find possible locations for a repository. In April 1980, just a month after the referendum, PRAV, an organization with the task to find a place with good geological conditions for a repository, tried to set up a testing site for proof drillings at Kynnefjäll, 100 km north of Gothenburg. However, the drilling team was met by intense local protests and had to withdraw. The protesters guarded the intended site for no less than 20 years. Also, in the other places that PRAV had identified as promising for a repository they met strong local protests, which could however not prevent the drillings. But these local protest groups were able to gain strong support from the local population and also from local politicians. All these local groups soon formed a national network called the Waste Chain which engaged university geologists as counter experts which strongly questioned the intended design of the repository. The local protests thus had more than a Not-in-my-backyard- (NIMBY-) character.

In parallel with these local controversies Swedish Parliament decided in 1981 about the financing of the future costs for handling nuclear wastes. Every reactor owner had to pay a certain amount for every produced kWh to a state Nuclear Waste Fund that would guarantee the financing of the future repository and other facilities. By the mid-1980s the power companies responsible for the final storage of spent fuel had established a new jointly owned organization, SKB, with the task to develop and build facilities for final storage. SKB reached the conclusion that it would be impossible to establish a repository at a site where the local population was strongly against it. Thus, the local opposition groups had won the first round in the controversy about final storage (Anshelm 2006a and b). The local opposition to test drillings will be analysed in event 3 below.

The Chernobyl disaster and its effects in Sweden

The debate on nuclear power decreased after the referendum but was suddenly revived again in the spring of 1986 after the disaster in Chernobyl. This disaster was in fact disclosed by Swedish nuclear experts. 30 hours after the accident increased radiation levels were detected at the Forsmark nuclear power plant in Sweden. A crisis team was set up by the Swedish Radiation Protection Agency and after analysis of the fallout and of the meteorological conditions it identified the Chernobyl nuclear station as the probable source for the fallout over Sweden. The Swedish findings forced the Soviet government to inform the world about the disaster (DsI 1986, 11).

Parts of northern and eastern Sweden were severely affected by the disaster and Swedish mass-media reported intensively about the increased radiation levels, and this caused much anxiety. The anti-nuclear movement experienced a revival as a result of the Chernobyl disasters. Demonstrations were arranged in many places all over Sweden demanding an immediate stop of all nuclear power. But this revival was short-lived and soon ebbed out. The Minister of Energy, Birgitta Dahl, had played an active role in the disclosing of the disaster and was deeply shaken by it. She rapidly commissioned an investigation of the disaster. This commission concluded that the Chernobyl accident did not change the earlier assessments of nuclear risks in Sweden, and it further argued that an immediate phasing out of nuclear power would have severe economic consequences.

Based on this report and further investigations Birgitta Dahl presented a proposal to start the phase out in the mid-90s, with a first reactor in 1994 and a second two years later. After Parliament approved this proposal, Dahl emphasized that the decision to start the phase out was "irreversible". This new policy was forcefully contested by industry and trade unions, representing a strong faction within the Social Democratic Party. They argued that such an "early phase out" – as they called it – would threaten jobs in industry (Högselius and Kaijser 2007). In the following year the Social Democratic Party experienced a strong internal conflict between an economic growth-oriented faction, and an environmentally oriented faction. The former won and as a result the energy portfolio was transferred from Birgitta Dahl to the trade union leader, Rune Molin in 1990.

Molin immediately started negotiations about a revision of the energy policy with the Centre Party and the Liberal Party, and the three parties reached an agreement in 1991 in which the "premature phase out" of nuclear power in the mid-1990s was postponed to an undefined future. The agreement also contained a new element: it underlined the importance of the deregulation and internationalisation of the energy sector in general and the electricity system in particular. Thus, five years after the Chernobyl disaster, Parliament made a decision to continue the Swedish nuclear programme unchanged. The "irreversible decision" to start the phase out in the mid-90s had in fact been reversed after a strong reaction from the pro nuclear side, while the anti-nuclear movement was too weak to influence the process. The Chernobyl disaster and its implications on Swedish energy policy are analysed in event 4.

Municipalities competing for a repository

After the failed attempts to find a suitable location for a repository in the 1980s, SKB initiated a new strategy in the early 1990s. It adopted a much more open and cooperative attitude towards municipalities, emphasizing that a decision about a repository only would be made if a local municipality was in favour of it. Based on more developed safety analyses, SKB argued that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts. This meant that it was no longer necessary to search for the best possible geological location in the whole country, but that the geology in large parts of the country was sufficiently good. After a stepwise screening of potential sites all over Sweden, SKB turned to municipalities in southern Sweden that already had nuclear facilities. Preliminary studies indicated that two of these, Östhammar (where Forsmark is located) and Oskarshamn, had the best conditions with inhabitants that were not averse to nuclear facilities and with suitable transport infrastructure (Anshelm 2006a, Lidskog 1998).

In 2002 more thorough studies of these two municipalities commenced including test drillings. The ensuing process was very different from previous attempts. Instead of having to deal with very reluctant local populations, SKB now had two positive local populations. After a long evaluation process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository on geological grounds. To lessen the disappointment in Oskarshamn they simultaneously decided that the future plant for constructing copper canisters for the spent fuel would be located next to the existing interim storage facility in Oskarshamn. The municipal competition for a repository is analysed in event 5.

Nuclear phase out or expansion?

The tripartite agreement in 1991 spurred what would become an institutional revolution in the Swedish electricity sector. New legal frameworks were introduced in 1996 in order to promote competition, and the ownership patterns changed dramatically; in particular a number of foreign power companies bought large shares of previously domestic energy companies, while Vattenfall expanded abroad, particularly in Germany where it bought power companies owning nuclear reactors and large coal mines (Högselius and Kaijser 2007). However, the nuclear issue did not disappear from the political agenda altogether. In 1997 a new tripartite energy agreement was made, this time between the governing Social Democrats, the Left party (former Communist party) and the Green party, and this agreement included a decision to start a phase out of nuclear power in the near future. As a result, the two reactors at Barsebäck were closed down in 1999 and 2005 respectively. That these two reactors were chosen had to do with their location only 20 km from Copenhagen. For decades, the Barsebäck plant had been a nuisance in the relations between the Swedish and the Danish governments.

In 2010, the time frame for phase out decided by Parliament after the referendum in 1980, ten reactors were still operating. These reactors had been upgraded and could generate more electricity than the twelve reactors did in 1985, and Sweden was still the country with most nuclear power per capita. In 2010, Parliament made a new decision on nuclear power, which allowed the construction of new reactors, but only at existing power plants and for replacing old reactors. For a number of years electricity prices in Sweden had been low, and due to increasing safety demands on reactors, particularly after the Fukushima accident in 2011, the reactor owners were forced to make large investments in safety improvements as well as in replacements of components that had reached the end of their technical life. In May 2015, the owners of the Ringhals nuclear power plant decided to close down the two oldest of their four reactors by 2020 for economic reasons, and in October the same year the owners of the Oskarshamn nuclear power plant also decided that the two oldest of their three reactors will be closed by 2020. At present, it thus seems as if economic rather than political conditions will dictate the future of nuclear power in Sweden, bearing in mind that political decisions regarding taxes and subsidies in the energy sector may have substantial economic impact.

Presentation of main actors

The first two organizations of importance for nuclear energy were the Atomic Energy Company, AE, and the National Defence Research Institute, FOA (now FOI). AE was established in 1947 as a limited company in which 4/7 of the shares were owned by the state and the rest by private industry, but the government had a dominant influence and provided most of the funding for AE. The main task of AE was to develop and design nuclear reactors, uranium mines, and reprocessing plants. FOA was established in 1945 by merging a number of separate military research institutes and became responsible for research on military applications of nuclear technology. FOA cooperated closely but discreetly with AE. Both AE and FOA had a dominance of nuclear scientists in leading positions. Public universities and in particular the technical universities, KTH and Chalmers, also played an important role early on, both for fundamental nuclear research and for educating nuclear scientists and engineers.

In the mid-1950s ASEA, Sweden's leading manufacturer of electrical equipment, also became involved in nuclear development. By this time, ASEA had developed the world's first 400 kV-line in close collaboration with the State Power Board, called Vattenfall. ASEA formulated a goal to become one of the world's leaders in heavy electrical equipment, and it saw nuclear power as an area of vital importance for the future. ASEA had a dominance of electrical engineers in leading positions and had a long tradition of developing and manufacturing electrical plants.

The main power producers in Sweden were the state owned Vattenfall and about ten private power companies. They were ambivalent towards nuclear power in the mid-1950s. They feared that the nuclear enthusiasm might threaten the exploitation of hydropower in the still untouched rivers in northern Sweden, which was their first priority. They were also hesitant about the future costs of nuclear power. But in the 1960s they changed stance and jointly purchased nuclear reactors. Most of the Swedish nuclear power plants have been co-owned by several power producers. Until the mid-1990s these companies were fully Swedish owned, but with the liberalization of the Swedish electricity market foreign companies, i.e. the German company E.ON (now UNIPER) and the Finnish company Fortum have also become major owners.

From 1956 there was a division of labour dictated by government in which AE developed and designed nuclear reactors (HWRs), ASEA built them and Vattenfall operated them – and the government funded it all. Both ASEA and Vattenfall challenged AE's role as main developer. They had collaborated closely in the development of high-voltage technology in the 1940s and 50s and wanted to continue a similar cooperation in the nuclear field but had to accept AE's leading role. However, in the mid-60s private Swedish power companies decided to purchase light water reactors, LWRs, from ASEA, and the latter managed to develop and build such reactors on its own without licenses from General Electric or Westinghouse, which was unique in Western Europe. In 1969 the reactor development part of AE merged with ASEA to form ASEA-Atom, and this new company came to harbour most of the country's nuclear reactor expertise. Research and materials testing activities at Studsvik remained in a reduced AE, now Studsvik AB, a private company. Also, the government and government agencies supported nuclear energy. Most of the research and development work up till the mid-1960s was government financed from the Ministry of Trade and the Ministry of Defence. From 1968 the new Ministry of Industry took over responsibility for energy matters from the Ministry of Trade. There has been an energy unit at these Ministries responsible for preparing Energy Bills, setting up committee's and new agencies and much more. The public servants in this unit, mostly engineers and economists, had a considerable de facto influence.

In 1956, Parliament passed an Atomic Energy Law, which led to the establishment of agencies for regulating fissile material and nuclear plants and their activities. At first, three temporary agencies were created, one for inspecting safety of reactors and security of fissile materials, one responsible for the siting of reactors, and one for radiation protection. In 1965 the third of these was formalized as the State Radiation Protection Institute, SSI. In 1974, the first two were merged and became the Swedish Nuclear Power Inspectorate, SKI. Finally, in 2008 SKI and SSI were merged and became the Swedish Radiation Safety Authority, SSM.

In 1972 a new company was established on government initiative for coordinating the purchase of nuclear fuel, SKBF. It was owned jointly by the reactor owning companies. In the late 1970s this company was given an additional task, to develop a method for final storage of spent nuclear fuel and it changed its name to SKB.

In a fairly small country like Sweden the organizations supporting the development of nuclear energy have been rather few, and the leading persons in these organizations have all known each other and formed a rather tight network, even though there have also at times been conflicts within the network. Around 1970 a very powerful "nuclear-industrial complex" had emerged, and there was a broad political support for nuclear power in Sweden from all political parties and from civil society as well, including influential organizations like the Federation of Swedish Industry and the Swedish central labour union, LO. There was very little criticism of nuclear power before 1972. In the late 1950s there had been an opposition against nuclear weapons, and these critics had also questioned that the early reactors were designed to enable weapons materials. But they had not questioned nuclear energy as such.

In the early 1970s an anti-nuclear movement emerged. It started among some scientists and engineers, which were influenced by the critique launched by American colleagues. Some environmental organizations also became critical of nuclear power due to close contacts with sister organizations abroad. In the 1970s the anti-nuclear movement gradually gained momentum also beyond the environmental organizations, in particular among young counter-culture people with experience from the student revolt in the late 1960s and the Vietnam and Chile solidarity movements, but also among peace organizations, women's organizations, and religious groups. In 1973 also two of the five parties in Parliament took an anti-nuclear stance, the Centre Party, with its base in the country side, and the Communist Party.

The anti-nuclear movement was heterogeneous and organizationally scattered and to overcome this, an umbrella organization called the People's Campaign against Atomic Power, FMA, was established in 1978. FMA decided to demand a referendum on the future of nuclear power, which was first rejected by a Parliamentary majority but later approved due to the strong sentiments caused by the TMI accident. The referendum campaign led to an enormous increase of the FMA membership and hundreds of thousands were engaged. However, the outcome of the referendum was a huge disappointment and an overwhelming majority of the activists became disillusioned and quit FMA, or FMK as it had been renamed.

FMK thus lost much of its strength as a national actor, but in some places that were chosen as sites for test drillings for possible nuclear fuel repositories, active local protest groups emerged in the 1980s. Moreover, other environmental organizations gained strength, for example the Swedish Society for Nature Conservation, SNF, and Greenpeace Sweden, which partly changed character and became professional lobby organizations rather than grassroots based activist organizations. In 1981 the Green Party was established in Sweden and it won its first seats in Parliament after the election in 1988. This Party absorbed some of the activists from FMK and became a strong anti-nuclear voice in Parliament.

Mass media have also played an important role in the history of nuclear energy in Sweden. In the early decades, media gave positive and uncritical accounts of nuclear technology, but in the 1970s newspapers, TV and radio became important arenas for debate about the pros and cons of nuclear energy. Media played particularly important roles in relation to the TMI, Chernobyl and Fukushima disasters and during the referendum on nuclear power (Holmberg and Asp 1984).

Showcase. The Referendum on Nuclear Power in 1980

Case History

The referendum on nuclear power that took place on March 23, 1980 represents the most intensive engagement with the nuclear power issue ever in Sweden. Hundreds of thousands of Swedes were actively engaged during the months preceding the referendum. Many leading politicians were also engaged as were representatives from industry, trade unions and lobby organizations. Mass media were filled with articles and programmes about the pros and cons of nuclear power and also with advertisements from the competing sides. Thus, the referendum is a fairly obvious choice as a showcase. Referenda in Sweden are unusual. Before 1980, there had been only three earlier referendums: one concerning a ban on alcohol in 1922, one about introducing right-hand car traffic in 1955, and one about a change in the pension system in 1957. In all these three cases opinions did not follow traditional party lines and a referendum was seen as a way to overcome this. It is Parliament that decides to arrange a referendum, and it is only advisory; it is the task of Parliament to interpret the result afterwards.

A proposal to organize a referendum on nuclear power was first proposed by the Communist Party in 1975 but was rejected by the other parties (Anshelm 2000). In the autumn of 1978, the proposal to hold a referendum came up again, this time within the Folkkampanjen mot Atomkraft (the People's Campaign against Atomic Power), FMA. The FMA had been established in March 1978 as an effort to create a national umbrella organization for the rather heterogeneous anti-nuclear movement. It encompassed a dozen organizations, some of which were non-political environmental or peace organizations, while others were political organizations, including the Centre Party and Communist Party, and also many parties not represented in Parliament, primarily from the left but also including the Christian Democrats.

The nuclear friendly parties in Parliament – the Social Democrats, the Conservatives and the Liberals – were still negative about a referendum and argued that the nuclear issue was too technically complicated for a referendum. To put political pressure behind the demand for a referendum the FMA launched a nationwide campaign to collect signatures on a petition for a referendum in the beginning of March 1979. On March 28, in the midst of this campaign, the Three Mile Island accident occurred, and all Swedish mass media reported extensively about it. The accident had a major impact on the public opinion, and a week later, Olof Palme, the party leader of the Social Democrats announced that he and his party had changed stance and now supported a referendum. The Conservatives and Liberals soon followed suit. For these parties, a referendum was a way to separate the nuclear issue from partisan politics, thus preventing the TMI accident from becoming a big issue in the upcoming elections in September 1979. The decision to organize a referendum was complemented by a decision to postpone the fuel loading of four new reactors until after the referendum (Fjaestad 2008).

The details of the referendum were decided after the general elections, which brought a new non-socialist coalition into office, with Fälldin as Prime Minister. After negotiations among the five parties in Parliament, an agreement was reached in mid-December 1979. When demanding a referendum, the FMA had foreseen a straight forward referendum with two alternatives, one for a phase-out and one for a continued expansion of nuclear power. However, the pro-nuclear parties split into two alternatives instead of one, for tactical reasons. The Social Democrats did not want to support the same alternative as the Conservatives. There were thus going to be three alternatives in the referendum that was to take place on March 23, 1980. Line 1 was supported by the Conservative Party, Line 2 by the Social Democrats and the Liberals and Line 3 by the Centre Party and the Communists (and the FMA). Each of the three lines was given 18 million Swedish krona to finance its campaign.

The ballots of Line 1 and Line 2 were largely identical. They proposed that besides the six reactors already in operation, six more reactors that were already completed or under construction should be brought into use. Beyond this no further expansion of nuclear power would be allowed. Line 2 had some additional points concerning, inter alia, public ownership of nuclear power plants and a ban on electric heating of dwellings. Line 3 proposed that the six operating nuclear reactors should be phased out within ten years and that no new reactors should be put in operation.

The ballots of Line 1 and 2 both began with the following sentence: "Nuclear power will be phased out at a pace that is possible with consideration to the need for electricity for employment and welfare" (Holmberg and Asp 1984, 95). They thus presented themselves as phase-out alternatives too, but in a far future. In the short term their proposals implied a threefold increase of nuclear production. In particular Line 2 had the aim to look like a "middle way" alternative and their slogan was: "phasing out, but sensibly" (Holmberg and Asp 1984, 90). The anti-nuclear movement was very upset both about the arrangement with three alternatives instead of two and about the other lines' efforts to look as phase-out alternatives, but it could not do anything about it (Kågeson and Kjellström 1984, Eriksson 1981, Interviews Daleus, Odell, Kågeson and Falk).

The referendum campaign started in mid-January and dominated political life and the mass media for two months with a peak in the weeks preceding the referendum. The three lines had very different organizational set ups and modes of campaigning and arguing (Holmberg and Asp 1984, Anshelm 2000).

Line 1 was closely linked to the Conservative Party and to industry. The campaign general was a 32 years old parliamentarian, Per Unckel, who was fairly unknown to the general public. The board of Line 1 also encompassed leading industrialists and scientists. The Swedish Federation of Industry established a lobby organization called Industries Energy Information to support Line 1.

Line 2 was linked to the Social Democratic Party, the Liberal Party and the main trade union, LO. The Social Democrats were in majority as they were a much bigger party. The trade union leader Rune Molin was appointed as the main spokesman of Line 2, while the liberal diplomat and former Foreign Minister Hans Blix was his second. Also, the Social Democratic parliamentarian Birgitta Dahl had a leading role and represented Line 2 in many debates. Line 2 strived to mobilize the trade unions to campaign at work places all over the country.

Line 3 was the most heterogeneous line with more than 30 supporting organizations including the Centre Party, the Communist Party, the Christian Democrats, parties far to the left and environmental and peace organizations. Its campaign general was Lennart Daleus, an unknown 33-year-old environmentalist representing Friends of the Earth. Line 3 also included social democrats, liberals and trade unionists that were anti-nuclear. The most prominent of these turncoats was Ulla Lindström, a former Minister and a grand old lady in the Social Democratic Party. This line quickly developed into a mass movement with several hundred thousand people organized in local committees all over Sweden. Many activists took part in study circles to learn more about energy issues, often based on the book Vote No (Kjellström and Kågeson1979) of which 170 000 copies were printed. These activists organized meetings, distributed campaign newspapers, and knocked on doors to talk with ordinary people (Eriksson 1981, Interviews Daleus, Odell, Kågeson and Falk).

In addition to the spokesmen and other representatives directly linked to the three lines the ordinary party leaders also played an active role in the campaign and did their best to try to convince their traditional voters to support their line. A good illustration of the differing characters of the three campaigns is the way they arranged their major activity before the election (Holmberg and Asp 1984, 100–103.). Line 1 organized its final meeting in a sober concert hall in Stockholm with speeches by a handful of the campaign leaders. The main point on the programme was a presentation making use of sophisticated audio-visual aids of a possible future crisis scenario, describing a conflict in the Middle East leading to rationing of petrol (as had actually happened in 1956 and 1973), and with the underlying argument that Sweden would be much better off if it expands nuclear power.

Line 2 had its final meeting in the labour movement's bastion "The People's House" in Stockholm. The theme of the day was "Don't make the 80s more difficult", and very prominent politicians and trade union leaders all argued that Line 3's proposal to phase out nuclear power in 10 years would create huge economic difficulties. "It's not only about the stereo and the car, it is about our jobs and social security" as the leader of LO put it (Holmberg and Asp 1984, 100).

Line 3 arranged demonstrations in hundred towns all over Sweden one week before the referendum. In Stockholm 25,000 demonstrators marched to the main sports arena, where a number of musicians and actors participated and Lennart Daleus was the main speaker focusing on the safety problems with nuclear power.

The slogan of the demonstration was “Say yes to life – say no to nuclear power” (Holmberg and Asp 1984, 101).

These three events also illustrate the kind of argumentation that the three lines pursued. Line 1 emphasized that nuclear power was crucial for further economic growth and for decreasing the dependency on imported oil. It also argued that nuclear power was safe and that Swedish nuclear plants were more reliable than the one at TMI. Even if its ballot stated that nuclear power would be phased out “at a pace that is possible with consideration to the need for electricity for employment and welfare” the representatives of Line 1 talked very little about this future phase out, but much more about the nuclear expansion in the immediate future.

Line 2 had a similar argumentatin as Line 1 and strongly emphasized that nuclear expansion was necessary for economic growth and social welfare. It also emphasized the need to develop alternative energy sources like wind and solar power but argued that it would take a long time before these sources could replace nuclear power. In the long run, sometimes the year 2010 was mentioned, a nuclear phase out should thus be feasible.

Line 3 emphasized the dangers of nuclear power, the risk of disasters in power plants, the challenge to store spent fuel for hundred thousand years, and the risk for nuclear proliferation. It argued that it would be possible to replace the six reactors in operation in the coming ten years through an ambitious programme for building wind power and combined heat and power plants and through measures for increased energy efficiency, and that such a programme would create many new jobs (Holmberg and Asp 1984, Anshelm 2002).

The outcome of the referendum was that Line 2 received 39.1% of the votes, Line 3 received 38.7% and Line 1 received 18.9%. As referendums in Sweden are only advisory it was the task of the Parliament to transform the referendum result into a political decision. In June 1980 Parliament set up four long-term goals for the energy sector:

– all nuclear power plants should be phased out by the year 2010,
– the country’s dependence on oil should be reduced,
– energy efficiency should be increased,
– a transition should be made to “an energy system based as far as possible on sustainable, preferably renewable and indigenous, energy sources with least possible environmental impact”.

It should be noted that the year 2010 was not in the ballot text of Lines 2 or 1 but was added by Parliament. It was based on an expected (economic) lifetime for nuclear reactors of 25 years and assumed that the last two reactors would be commissioned in 1985. Parliament thus formulated goals for the energy sector

Figure 1 “Nordiska Atommarchen 1976” – “Nordic Anti-Nuclear March 1976”; banner, “Instead of Nuclear Power and Parliamentary Debates – Soft Energy and Worker’s Power” implying a major redirection sometime in the distant future and it did not specify a time table for the phase out. In the short term, this decision meant a return to "business as usual", after a period of intense politicization of energy matters. A few weeks after the referendum, the government approved fuel loading of four reactors that were completed but not yet operating. Furthermore, the construction of two additional, even bigger reactors was accelerated. These were completed and taken into commercial operation in 1985.

The outcome of the referendum was a huge disappointment for all the Line 3 activists that had campaigned so intensively in the previous months. There were no plans for how to continue the nuclear opposition in the case of a defeat. Moreover, it became difficult to question the expansion of nuclear power when a referendum had approved it, and a majority of the activists became disillusioned and quit the People's Campaign.

Type of event

This is the most well-known event in the history of nuclear power in Sweden and much research has been devoted in particular to the political aspects of it. There is however not so much research on the emergence, functioning and character of the anti-nuclear movement, despite its size and importance.

Identification of actors

The referendum was initiated by FMA; an umbrella organization for environmental groups and political parties that were critical of nuclear power. When the decision about a referendum was taken, the Line 3-alternative grew very rapidly all over the country, engaging several hundred thousand people. It was a rather heterogeneous movement, but a central campaign office tried to organize it and to produce campaign material that was distributed to all the local groups. Line 1 and Line 2 organized campaigns that were more similar to ordinary election campaigns enrolling party organizations, trade unions, industry and lobby organizations. Mass media played a very important role during the referendum campaign both as arenas for debates and by describing and discussing the likely consequences of the different alternatives in the referendum. Public service radio and TV are obliged to be impartial and objective, which was not easy. They organized debates with spokesmen of the three lines that were of particular importance. Daily journals in Sweden are often linked to a political party and many took a clear stance on their editorial pages, but most opened their pages for debates with participants from all lines.

Arguments and behaviours

The anti-nuclear Line 3, focused primarily on the dangers of nuclear power. The risk of accidents in reactors, as illustrated by TMI, was particularly emphasized, but also the unsolved final disposal of spent fuel, the environmental risks of uranium mining and the risk of nuclear proliferation. Furthermore, it proposed a fast development of renewable energy sources and of more efficient energy use. Such a development, it was argued, would make it possible to phase out the six operating nuclear reactors in ten years and replace them primarily with renewables and efficiency measures.

Line 1 and Line 2 also acknowledged that nuclear power had problematic aspects and should be phased out in the long run, when there were renewable energy technologies that could replace them. But they argued that it would be an enormous economic loss not to use the reactors that had been built or were under construction and that this would threaten jobs and economic welfare. Line 2 argued that twelve reactors should be used during their technical life time, which was assessed to be about 25 years. This would mean “a phase out with sense”.

Public engagement

The referendum was organized according to strict laws and rules that govern advisory referendums in Sweden in which Parliament has the final say about the setup for such a referendum. Nuclear power and energy issues in general have never been discussed as intensively and wide spread in Sweden as during the half year preceding the referendum.

Events

Critical view to the selection process of the five events

The showcase and the five events below have been chosen primarily because of their significance in themselves, but also in such a way that they jointly reflect different political eras, different issues (weapons, nuclear power, and nuclear waste), local issues versus national issues, transnational influences, and the involvement of different kinds of actors.

The first event is the nuclear weapons controversy in the late 1960s and early 70s. This was the first time that nuclear technology was seriously debated in Sweden, and this debate took place on three different arenas with different kinds of participants. It was also influenced from abroad.

The second event concerns a number of inquiries on energy futures in the late 1970s. In Sweden government commissions are often appointed when political conflicts emerge, and when energy, and in particular nuclear power, became a contested area several commissions were set up, with representatives from stake holders and political parties. These commissions analysed different future options and tried to find compromises.

The third event is about the local protests that emerged in the early 1980s in response to attempts to make drillings and investigations for locating a nuclear fuel repository. The drilling teams came without prior notice, and they often triggered a strong local opposition. These local groups formed a national network called the Waste Chain to coordinate their resistance.

The fourth event is the Chernobyl disaster in 1986 and its political implications in Sweden. This disaster was disclosed to the world by a Crisis team at the Swedish Radiation Protection Agency, SSI, and the fallout over Sweden was severe. The disaster thus led to a renewed debate about the risks of nuclear power and the pace of the phasing out of Swedish reactors.

The fifth event is about the further process of locating a place for a repository in the 1990s which was a comprehensive process including both geological investigations and striving for political consent. In the end, the process became almost a "beauty contest" between two municipalities, both already hosting a nuclear plant, striving to be chosen as sites for nuclear waste. Bedrock quality decided the outcome.

Event 1: The nuclear weapons controversy

Case history

In 1956 the Swedish Parliament decided on an ambitious programme for the development of nuclear technology, which came to be known as the Swedish Path. The long-term goal of this programme was the development of a domestic nuclear fuel cycle in order to increase self-sufficiency of energy supply. It also had a less overt military aspect to enable the production of nuclear weapons. When the knowledge about the military aspects of the Swedish Path became more generally known, nuclear weapons became a contested political issue. Partly the division was on the right-left scale, with most politicians from the right and centre parties supporting nuclear weapons, while many politicians from the left were more sceptical. In particular the governing Social Democrats were divided; a growing faction within the party, led by the Social Democratic Women's Association headed by Inga Thorsson, wanted to put a halt to the development of nuclear weapons. Also, the government itself was divided on the issue with the Defence Minister, Sven Andersson, supporting nuclear weapons while the Foreign Minister, Östen Undén, was opposing them (Agrell 2002).

In 1957, the Supreme Commander, Nils Swedlund, openly demanded further funding for developing nuclear weapons, and this triggered an intensified debate. In March 1958 an influential little book entitled *Instead of the nuclear bomb* was published. It was co-authored by a well-known novelist and pacifist, Per Anders Fogelström, and a social democratic student leader and reservist officer, Roland Morell. They argued that Sweden should abandon the bomb and instead use the money for development aid. The book had a strong impact and was presented in newspapers, radio and even TV, which was for the first time used as an arena for political debates. The two authors were also invited to speak at meetings all over Sweden. At one of these meetings in June 1958, an initiative was taken to establish a new organization or network called Aktionsgruppen mot Svensk Atombomb (the Action Group against Swedish Atomic Weapons), AMSA. In the following year the members of AMSA were very active; they wrote articles in newspapers, participated in radio and TV debates, talked at public meetings and prepared material for study circles.

AMSA chose to call itself an "action group" to demonstrate that it did not strive to become a long-lasting peace organization and compete with existing organizations. It was very informal without a board or membership fees and it was limited to the 21 people that joined from the beginning. These included some well-known authors, journalists, academics and the Arch Bishop. They had their sympathies with different political parties, but none of them was communist. One reason for not admitting more members was that AMSA did not want to be suspected to be a pro-communist organization. Moscow spurred communist parties in Western Europe to create peace organizations opposing nuclear weapons, and the Swedish Peace Committee was one of these.

There were also many that actively argued that Sweden should develop nuclear weapons in order to defend itself against possible attacks by the Soviet Union: leading officers, researchers at FOA and AE and most parliamentarians belonging to the Conservative, Liberal and Centre parties were all in favour of this option. The main Swedish daily, *Dagens Nyheter,* had an influential editor in chief, Herbert Tingsten, who was a former professor of political science. He argued very forcefully for Swedish nuclear weapons. Moreover, in 1959, Per Edvin Sköld, an influential Social Democrat who had been Minister of Defence during World War II and Finance Minister after the war, edited a book with the title *Swedish atomic weapons,* which was a kind of reply to AMSA and to Fogelström's and Morell's book with six contributors – officers, researchers, a diplomat and a journalist – all pleading for the development of nuclear weapons.

Within the Social Democratic Party, the opinions were much more divided. In parallel with AMSA's public campaign the nuclear weapons issue was also intensively discussed. In fact, the nuclear weapons controversy threatened to cause a major disruption in the party, and Prime Minister Tage Erlander therefore set up a special study group in the autumn of 1958 including the main proponents and opponents within the party. He appointed his newly recruited political aide, Olof Palme, as secretary in the group with the task to try to reach a compromise concerning the future nuclear weapons research. The choice was between on the one hand "protection research" aiming at understanding nuclear weapons better in order to construct bomb safe shelters and other protective devices, and on the other hand "construction research" aiming at constructing and producing nuclear bombs. After more than a year of discussions, the study group presented its report in November 1959 and recommended what they called "extended protective research" in the coming years until 1963, when a decision whether to build bombs or not would have to be made. In reality, this compromise did not impede the efforts of the FOA researchers, as the production of plutonium in the "civilian reactors" would not start until 1964 anyway (Agrell 2002).

The main purpose of the study group was to neutralize the nuclear weapons issue in the coming parliamentary elections in September 1960. All parties, except the Communists, could agree on the formula of extended protective research and abstained from discussing the issue in the election campaign. However, AMSA did not want the nuclear weapons issue to be buried in this way. In April 1960 they made a plea for a referendum on nuclear weapons, and started to gather signatures for their plea, but they were not able to muster the necessary number of signatures. When this campaign failed, AMSA more or less dissolved.

One of the leading AMSA members, the journalist Bertil Svahnström, took the initiative to form a new organization called Kampanjen mot Atomvapen (Campaign against Atomic Weapons), KMA, in the spring of 1961. The establishment of KMA was inspired by the British organization Campaign for Nuclear Disarmament established in 1955 and the Danish Kampagnen mod Atomvåpen and like these organizations it strived for different kinds of members and other types of activities than AMSA had done. While AMSA was dominated by middle age intellectuals, KMA attracted young people not least students, most with a middle-class background. It had a more international orientation and opposed nuclear armament in general, not only in Sweden. And it focused on organizing marches and manifestations rather than meetings and study groups. The first major event was a 2-day and 35-kilometre-long protest march from a square in central Stockholm to FOA's research facility in Ursvik in September 1961. The march assembled 800 participants and demonstrated the ability of KMA to mobilize activists. It also introduced a new kind of political manifestation in Sweden, following the examples from Britain and Denmark. The following year a new 50 kilometres march from Södertälje to Stockholm was organized during Whitsuntide attracting no less than 2000 participants, and similar marches were arranged also in 1963 and 1964, however with decreasing numbers of participants (Agrell 1999).

The issue of constructing Swedish nuclear weapons lost its political urgency in the early 1960s. The political compromise concerning "protection research" was meant to delay the issue. However, leading militaries, gradually changed their views on the military benefit of nuclear weapons, and after Nils Swedlund stepped down as Supreme Commander in 1961, no more concrete demands for nuclear weapons were expressed from the military. The same year, the Swedish foreign minister presented a plan at the United Nations in which he proposed that nuclear free countries would shape regional nuclear free zones. This so called Undén-plan was adopted by the UN in November 1961. In 1968 Sweden formally decided not to develop nuclear weapons and to sign the Non-Proliferation Treaty.

In the international negotiations concerning non-proliferation in the 1960s and disarmament in the 1970s, Sweden as a small neutral country with high competence in the nuclear domain played a prominent role. One example is Sigvard Eklund, who was appointed director of the IAEA in 1961 and remained so for no less than twenty years, when he was replaced by another Swede, Hans Blix. Eklund's main task as head of IAEA was to prevent civilian nuclear programmes from benefitting military programmes, and he had the perfect background for this task as this was something he had been doing in the previous fifteen years in Sweden! Another example is Rolf Björnerstedt, who had a senior position at FOAs division for nuclear weapons research. He took an active stance for Sweden abstaining from nuclear weapons in 1965 (Björnerstedt 1965) and was one of the founders of the Stockholm International Peace Research Institute, SIPRI. In 1969 Björnerstedt was appointed Head of the UNs Disarmament Division in New York.

It is hard to measure the direct impact of the anti-nuclear weapons movement, but official Swedish policy changed in the way this movement argued for. Sweden decided not to construct nuclear weapons and became a strong proponent internationally for nuclear disarmament.

Type of event

The nuclear weapons controversy took place in parallel both outside and within the formal political system. It was initiated in 1958 by a loose group (AMSA) of well-known intellectuals critical of nuclear weapons with access to mass media. They were able to create a media campaign and a political debate, which in turn triggered a counter reaction from leading militaries and others. The controversy also became prominent within the Social Democratic Party. In particular its Women's Association took a strong stand against the development of nuclear weapons. A special study group was setup to formulate a compromise. This compromise partly led to the dissolution of AMSA, which was replaced by a new political organization – inspired by the British CND – organizing protest marches and other public events. The nuclear weapons controversy has been recognized by some earlier research, but not very much.

Identification of actors

The controversy was initiated by independent intellectuals forming AMSA, by the Social Democratic Women's Organization and by the Swedish Peace Committee, dominated by the Communist Party, which were all opposing Swedish development of atomic weapons. Later on, KMA took over after AMSA.

The main proponents for developing atomic weapons were leading militaries, researchers at the National Defence Research Institute (FOA), and researchers at the Atomic Energy Company.

Leading politicians, including government members, were also strongly involved in the controversy on both sides. Others, like the Prime Minister and his assistant, tried to find a compromise to neutralize the issue which threatened to split the Social Democratic Party.

Arguments and behaviours

The opponents of atomic weapons argued that such weapons would be detrimental to Swedish security and increase the risk of nuclear warfare affecting Sweden. Some of them further argued that Swedish security would increase if the resources used for nuclear weapons research were used for development aid instead. Most opponents did not question the civilian nuclear programme or a strong military defence. They demanded that research and development of nuclear weapons should cease and that no bomb material should be produced in the future Swedish reactors.

The proponents argued that Sweden needed tactical nuclear weapons to effectively defend itself against an attack from the Soviet Union. They argued that the Soviet Union would use tactical nuclear weapons irrespective of if Sweden had such weapons or not, and that Sweden would be much more effective in its resistance if it also possessed such weapons. Thus, the possession of such weapons would reduce the risk of an attack, as the cost for the attacker would be much higher. They demanded that research and development of nuclear weapons should continue and that the future Swedish reactors should be designed to produce weapons grade plutonium.

The members of AMSA were very active communicators; they wrote booklets, articles in newspapers, participated in radio and TV debates, talked at public meetings and prepared material for study circles. The proponents of nuclear weapons tried to match AMSA and also produced booklets and articles. KMA also organized other types of events, in particular protest marches.

Within the governing Social Democratic Party, a special study group was set up with party members representing both opponents and proponents of nuclear weapons. This was a rather unusual measure to avoid a splintering of the party.

Public engagement

There was no attempt by public authorities to engage the public at large. On the contrary, the agencies involved in developing nuclear weapons tried to keep this as discrete as possible. The engagement was thus initiated from below, from influential intellectuals. Within the Social Democratic Party, a deliberative process was organized to handle the controversy.

Event 2: Public inquiries on energy futures in the 1970s

Case history

In Sweden government commissions have played an important role for preparing political reforms and major changes of policy. When a commission has published its final report, the Ministry in charge sends it to stakeholders to get a consultation response. The report and these responses are often an important basis for the formulation of government Bills. In the early 1970s a number of conflicts emerged in the energy sector: the further expansion of hydro power was contested by environmentalists, nuclear power was questioned as risky, and the oil crisis in 1973 demonstrated Sweden's extreme dependency on oil imports. A large number of government commissions were set up to handle these issues. Some of the commissions that were primarily intended to provide new insight had mainly experts and civil servants as members, while others that were intended to try and reach political compromises, also had politicians and representatives from interest organizations as members.

In the early 1970s there was a firm belief among public servants, politicians and experts of different kinds that the fast growth in energy consumption that had prevailed for a century would continue in coming decades (Anshelm 2002). This is clearly reflected in the final report from a government commission which presented its report in 1970 (Energikommittén, SOU 1970, 134). It was a pure expert commission without any politician. The commission presented a forecast for 1985 in which it presumed that the high rate of increase in energy consumption in previous decades would continue and that electricity would provide an increasing share of the total. This implied that the increase of electricity production was expected to be about 7 % per year, most of which in the form of new nuclear plants and that more than 20 reactors would need to be built by 1985. Two years later the Swedish power producers made a forecast for 1990 (CDL 1972) in which 24 reactors were planned to be built by 1990. This forecast was taken as a point of departure in two goverment commissions that investigated two aspects of nuclear power, the possible location of such plants close to cities to enable cogeneration of heat and power (Närförläggning av kärnkraftverk, SOU 1974, 16), and the final disposal of nuclear waste (Kärnkraftens högaktiva avfall, DsI 1974, 6).

This belief in an almost inexorable exponential future growth in energy consumption was modified in the mid-1970s. In the autumn of 1974, less than a year after the Oil Crisis, a government commission called the Energy Forecast Commission presented a report in which it foresaw a reduction in the rate of increase of future energy growth, from the historical growth of 4.5 % (since 1955) to between 2.4 to 3.4 % up till 1985 and between 1.6 to 2.8 % from 1985 to 2000. In the Energy Bill presented in the spring of 1975, the Social Democratic government based its planning on the lower of these forecasts and presented a plan for 13 nuclear reactors in 1985.

The most extensive of all the government commissions in the 1970s was the so-called Energy Commission set up by Olof Johansson, the new Energy Minister in the Fälldin government that took office after the elections in 1976. Johansson was like Fälldin critical to nuclear power and he thus wanted the commission to inquire different energy futures including alternatives in which nuclear power is phased out. The commission had fifteen members, half of which were politicians from all the five parties in Parliament, and the rest were experts or representatives of influential organizations. Moreover, the commission set up five expert groups concerning health, safety and environment, energy supply, energy usage, policy instruments, and R&D with about a dozen experts in each. The commission started its work in January 1977 and presented its final 600-page report after only fourteen months (Energi, SOU 1978, 17). Seven of the fifteen members formulated extensive reservations to the conclusions of the commission. In addition, the expert groups produced more than 70 (!) background reports on a very large range of topics. The commission even gave an assignment to three environmental organizations to formulate an energy plan, and this resulted in the report MALTE 1990. *The environmental movements alternative energy plan* (DsI 1978, 11), later became the basis for Line 3 in the referendum.

The task of the commission was to prepare a basis for a coming Energy Bill concerning Swedish energy policy for the time period until 1990. It did so by first assembling and analysing much material on environmental, economic and technical aspects of energy sources, and then formulating four different scenarios for the development up to 1990, one with a phase out of the six nuclear reactors in operation until 1985, one with a phase out until 1990, one with an expansion to thirteen reactors in 1990, and one with an expansion to fifteen reactors in 1990. The majority of the members recommended the third of these alternatives, while a minority recommended some of the others.

In many ways, the intensive work in the commission was a breeding ground for its members. Two of the politicians, Birgitta Dahl and Carl Tham, became future energy ministers and some of the others became leading spokesmen for their parties in energy matters. Two of the members, Per Kågeson and Björn Kjellström, became leading spokesmen for the People's Campaign during the referendum, and wrote a very influential book Vote No that became something of a bible for the Line 3 activists and was printed in 170 000 copies. Thus, much of the analysis and argumentation that was used during the referendum by the different lines were first developed within the Energy Commission.

The time frame of the commission was up to 1990, a little more than 10 years. This is a rather short time for changing a country's energy system as it often takes at least 10 years to plan and build a major energy plant, and even longer to develop new energy technologies. In 1974 a Secretariat for Futures Studies had been established as a kind of think tank within the government. This Secretariat launched an ambitious future study on energy in 1975 and presented its final results in a book titled *Solar versus Nuclear* (Lönnroth et al. 1978), published half a year after the Energy Commission had published its report. This book outlined two dedicated future alternatives thirty years into the future, one based almost entirely on nuclear energy and the other entirely on renewable energy, and the authors argued that both these alternatives were feasible in this time perspective and that the choice of energy system affected society at large; a "nuclear Sweden" would be centralized, police guarded and expert dependent, while a "solar Sweden" would be more decentralized, democratic and community based. *Solar versus Nuclear* received much public attention and its key message, that very different future energy systems can be achieved with a clear energy policy, was important during the referendum campaign (Anshelm 2000).

The 1970s ended with two more energy commissions. After the TMI accident the new liberal Energy Minister, Carl Tham, appointed a commission to investigate if the accident motivated a reassessment of the risk of accidents in Swedish reactors. And after the decision to organize a referendum another commission was set up to investigate the consequences of a phase out of nuclear power to 1990 for the economy, employment and environment as compared with expanding to twelve reactors. The members of the former commission were all experts not politicians, while the latter included both categories. The first commission produced a report entitled *Safe nuclear power?* (SOU 1979, 86) with an analysis of the TMI disaster, suggestions for a number of measures to increase safety in Swedish reactors (for example installation of filter chambers to reduce emission of radioactive isotopes in case of a reactor melt-down) and the conclusion that a reassessment of the risks was not motivated. The second commission originally had representatives from both the pro- and anti-nuclear camps, but the latter left the commission after some time because they thought that the whole approach was too biased. The commission concluded that a nuclear phase out in ten years would cause slower economic growth, an increase of unemployment and increased pollution due to higher use of fossil fuels but reduced risk of nuclear accidents (Konsekvensutredningen, SOU 1979, 83).

All these government commissions in the 1970s were mainly populated by engineers and economists and had a fairly technocratic and quantitative approach. They produced an enormous number of forecasts of future "energy balances" with the help of econometric models. And this approach affected the political debate which was often characterized by "reactor exercises" when proponents and opponents of nuclear power referred to different forecasts to substantiate their argumentation (Lindqvist 1997). But within this technocratic approach a paradigm shift occurred during the 1970s. While there was belief in a strong link between growth in GDP and energy consumption, and a conviction that energy consumption would continue to grow at a high pace in the beginning of the decade, the forecasts for future growth of energy consumption were much lower at the end of the 70s. This also affected the number of planned reactors in the 1990s which dropped from 24 to 12.

Figure 2 Barsebäckmarch 7 August 1976: The last slogans are being painted before marching off from Landskrona, banner: "Stop nuclear power"

Type of event

Government commissions are an important instrument in the Swedish political system when there is a need for new reforms or policy changes, and such commissions often provide important material for government Bills. There were unusually many government commissions on energy issues in the 1970s and the work in these commissions shaped a discourse that was influential for a long time. There has not been very much research on this topic.

Identification of actors

The Ministers responsible for energy during the 1970s (Rune Johansson, Olof Johansson and Carl Tham) formulated the missions for the commissions and appointed their members. The members, and in particular the chairmen, of the commissions were of course important actors, but also the secretaries and experts working for a commission could play in important role. Many times, some members/experts/secretaries participate in several commissions and they can get a strong influence through their overview. Most of the members of the commissions were economists or engineers working as civil servants or employees in energy companies, and they were often pro nuclear. But gradually politicians and experts with dissenting opinions were also appointed to the commissions to broaden the discussions and help formulate compromises. The Secretariat of Futures Studies, which made the influential future study on energy *Solar versus Nuclear*, was a kind of a government think tank on the future with a fairly high degree of independence.

Arguments and behaviours

The commissions that made energy forecasts employed a fairly technocratic and quantitative approach based on econometric models. The choice of different assumptions about key variables such as the future prices of different energy sources, or the growth or decline of different sectors of industry had a big impact on the forecasts, and the commission members would discuss such assumptions at length and outline a number of alternative scenarios including differing numbers of nuclear reactors, which was sometimes somewhat condescending referred to as "reactor exercises". The government commissions on energy developed a specific discourse focusing on economy and technical choices, while wider societal implications were often not discussed. The anti-nuclear members of the commissions adjusted their argumentation to this; they were subjected to the power of the discourse.

Public engagement

The ongoing work of a government commission was not public, but the resulting published report was at times widely discussed. Moreover, in some commissions there were representatives of different stakeholders, and these representatives had intense debates and arguments that later could influence the public debate.

Event 3: Local protests against a repository

Case history

On April 21, 1980, less than a month after the referendum, a number of heavy trucks loaded with drilling equipment were heading for Kynnefäll, a mountain area about 100 km north of Gothenburg. Their aim was to set up a testing site for test drillings to assess if Kynnefjäll was a suitable place for a nuclear spent fuel repository. However, the small forest road leading to the mountain was soft after heavy rain the previous days and the trucks got stuck in the mud. The news about the trucks spread quickly in the vicinity of Kynnefjäll and within a day a protest action had been organized. The protesters surrounded the trucks and the drilling team realized that they would not be able to reach their intended destination and turned back. To prevent future attempts to establish a drilling site on the mountain, the protesters organized a continuous watch keeping at the road towards the mountain. At first a tent was set up, somewhat later it was replaced by a caravan, and finally a little house with four beds was built at the road site. The protesters formed an organization, Save Kynnefjäll, and were able to gain much support from the local population and from a majority of the local politicians. Partly this had to do with a previous controversy in the late 1960s when the Atomic Energy Company had proposed to build an enrichment plant in this area, which had spurred an active local resistance (Anshelm 2006a).

After the first attempt to set up a proof drilling site had failed, the organization that was responsible for the proof drillings, PRAV, organized several information meetings when their experts explained the principles of the intended repository. But Save Kynnefjäll enrolled counter experts that questioned these experts and the local population remained hostile to drillings. As a result, PRAV decided to give up its attempts to establish a drilling site there. However, the members of Save Kynnefjäll were not convinced about the retreat of PRAV. They kept guarding the road to Kynnefjäll from their little house for 20 years and became a symbol for local opposition to nuclear power (Lidskog 1994). They ended their guard only in February 2000, after the Minister of the Environment, Kjell Larsson, wrote a formal guarantee that no repository would be placed at Kynnefjäll.

The background to the attempt to establish a drilling site at Kynnefjäll was that the Swedish Parliament had introduced a new law in 1977 called the Stipulation Act, which stipulated that reactor owners had to demonstrate that they would be able to handle the spent fuel from their reactors in a totally safe way to get permission to start operating new reactors. This Act had spurred the Swedish power companies to jointly pursue an intensive research project about a methodology for final storage of spent fuel, alternatively of the high-level waste created if the fuel was reprocessed. In 1979, they had received approval from SKI for their so called KBS method. After the referendum, the uncertainties about the future of nuclear power had disappeared and it was now clear that about 8000 tons (from 12 reactors operating 25 years each) of spent fuel would have to be stored. Moreover, all reactor owners had to pay a fee in proportion to how much electricity they had generated to a new Nuclear Waste Fund (Kärnavfallsfonden) to cover the future costs for disposing nuclear waste. All this triggered a search for possible locations of a repository, and Kynnefjäll had been identified as one suitable place by PRAV, an organization established by the owners of the nuclear plants, that was responsible for the search.

PRAV had identified about a dozen potential places for drilling sites, where geologists believed that the rock had a very high quality, and after the failure at Kynnefjäll they made a new attempt in December 1980 in the valley of the river Voxna. This time they were able to set up their drilling equipment before any locals managed to organize protests. But a protest organization, Save the Voxna Valley, was soon set up and was able to get strong local support. In spite of demonstrations and petitions, PRAV started their drillings and this spurred Save the Voxna Valley to organize a blockade of the drilling site. PRAV called the police, which broke the blockade and arrested three of the protesters, which were later sentenced to fines (Anshelm 2006a, 70).

Also, at the other locations that PRAV had identified as suitable for drilling local opposition groups were established as soon as the drillings commenced, following the examples from Kynnefjäll and the Voxna Valley. These groups organized demonstrations, public discussions and were often able to mobilize strong opposition. At one occasion a local resistance group (in Klipperås) demanded that independent geologists should be allowed to make an analysis of the drilling materials. When this was rejected activists dressed as Santa Claus stole l40 meter of drilling cores, and the independent geologists analysing this material concluded that the local rock had vast deformation zones making it unsuitable for a repository (Anshelm 2006a).

Figure 3 Poster of the Swedish Anti-Nuclear Campaign Organisation

All these local groups not only created strong local opposition; they also formed a national network called the Waste Chain, which engaged critical geologists, chemists and engineers in a critique of the KBS method at large. Their resistance was thus not only of a Not-In-My-Back-Yard character but questioned the plans for final storage in general. For example, in 1982 a delegation with representatives from four local groups went to Stockholm and made a visit to government officials to present their views. In 1981 the power companies responsible for the final storage of spent fuel had established a new organization for this purpose, SKB (originally SKBF, also handling fuel procurement). SKB made drilling attempts in 14 different places and were met by local resistance groups every time and at a number of times they even called the police to keep protesters away from the drilling sites. Finally, SKB concluded that it would be impossible to establish a repository at a site where the local population was strongly against it, and therefore abandoned all the drillings. In the early 1990s SKB had revised its strategy and would make a new start to identify possible locations, as is described in event 5 below (Anshelm 2006a).

Type of event

This event is an example of local resistance to the nuclear industry and of rather hostile confrontations where the industry called for assistance from the police at a number of times. There has been some research conducted on this event.

Identification of actors

Local individuals, upset by the nuclear industries intention to make proof drillings in their neighbourhood, quickly organized new organizations, like Save Kynnefjäll, with the single purpose of stopping these drillings. They were able to get strong support from ordinary citizens and local politicians. These local protest organizations formed a national network, the Waste Chain, and could muster support from counter experts, not least academic geologists who were critical of the nuclear industries plans for a repository.

The nuclear industry was obliged by the Stipulation Act to develop a method for storing spent nuclear fuel and for identifying a location for a repository. In the early 1980s the task of pursuing proof drillings in order to find places with suitable geological formations was given to PRAV, an organization established by the owners of the nuclear plants. In 1981 PRAV was replaced by SKB.

Arguments and behaviours

The local organizations first argued against a repository in their own backyard, but soon developed a more general critique of the intended method for a repository with the aid of counter experts in particular geological researchers at universities.

PRAV and later SKB argued that it was a matter of overarching ethical importance for the whole country to find places with the most suitable geological conditions for a future repository, and that proof drillings were a necessary step. PRAV tried to establish drilling sites without first informing the local public of their plans, and this proved to be very provocative and generated much resistance.

The local organizations primarily campaigned regionally to get support for their opposition. At a few times they also used illegal methods, like erecting blockades and stealing materials from proof borings to let their counter experts analyse them. By forming a national network, the Waste Chain, the local groups could learn from each other and organize some joint visits to national politicians in Stockholm.

Public engagement

The local public engagement was very intense when PRAV commenced their proof drillings without informing beforehand, and the engagement thus came from below, from the opponents. There was a mutual distrust between the local protest organizations and PRAV/SKB, and very little dialogue between them.

Event 4: Chernobyl and its political effects in Sweden

Case history

Monday morning, April 28, 1986, was dramatic at the Forsmark nuclear power plant, 100 kilometres north of Stockholm. As the night shift came off work passing through the routine contamination control, the workers all showed enhanced levels of radioactivity on their clothes. Further investigation revealed a thin layer of radioactive dust on the grounds all around the power station, but no evidence of leakage or any other mishap. At 10 am, the contamination was reported to the Swedish Radiation Protection Agency (SSI) in Stockholm, which immediately assembled a crisis team of diverse experts to investigate the situation. The nuclear specialists soon reached the conclusion that the radiation stemmed from a reactor, not a nuclear bomb test. The meteorologists analysing wind speeds and directions identified four nuclear stations in the Soviet Union as possible sources for the contamination.

When these findings were presented to the Swedish Minister for Energy, Birgitta Dahl, in the afternoon, she immediately instructed the Swedish ambassador in Moscow to ask the government what was happening. A few hours later the Soviet government confirmed it was handling a power reactor that had been "damaged", without specifying which reactor or what kind of damage. Further analysis by the crisis team suggested that it was the Chernobyl nuclear plant in Ukraine that had been damaged, and it requested the Swedish Space Corporation for remote sensing images of the area. A few days later the Space Cooperation produced an image of the reactor site, with a strong heat plume from Reactor 4, proving that a major accident had indeed occurred. Thus, the radioactive measurements at Forsmark and the subsequent analysis by the Swedish crisis team disclosed the Chernobyl disaster to the world (DsI 1986, 11).

Due to North Westerly winds a fairly large part of the radioactive particles that were released during the Chernobyl disaster passed over Sweden during the night between April 27 and 28. In areas where it rained that night fairly high levels of radioactive fallout came to the ground. In fact, outside the Soviet Union, Sweden was the most affected country by fallout from Chernobyl. Swedish mass-media reported intensively about the disaster and the increased radiation levels, and this caused much anxiety. Many parents were afraid to let their children play outside, and the Radiation Protection Agency had a hard time informing and calming the general public. Its General Director appeared on the TV news almost every day for a couple of weeks. Farmers in the contaminated areas could not let their cows out to graze and had to dump their milk if contaminated. Reindeer herders had to discard no less than 80 % of all the reindeers in the year after the disaster (Moberg 2001).

When the Chernobyl disaster occurred, the anti-nuclear movement was severely weakened after several years of decay. The disaster led to a revival. The former members put on their "nuclear power – no thanks" badges again, and in mid May 1986, demonstrations were arranged in many places all over Sweden, and ten thousand people gathered in central Stockholm demanding an immediate start of the phasing out of nuclear power. Mass media were filled with articles about the disaster and with debates concerning the risks of nuclear power. The opponents to nuclear power argued that the disaster proved the danger of nuclear power in general, and some of them demanded an immediate phase out of all Swedish reactors. The proponents, including scientists, industrialists and trade unionists, claimed that Swedish reactors were fundamentally different from Soviet reactors, and that a disaster like the one in Chernobyl was impossible in Sweden. The poll institutes registered a large increase of negative attitudes to nuclear power (Anshelm 2000).

The governing Social Democrats were still in shock after the assassination of their party leader and the Swedish Prime Minister Olof Palme two months earlier. They were sensitive to the protests and the increase of anti-nuclear sentiments. Birgitta Dahl, the Minister of Energy, had played an active personal role in the disclosing of the disaster and was shaken by it. Moreover, one of her closest advisors was Peter Larsson, a former leader in the anti-nuclear movement during the referendum campaign. Dahl rapidly commissioned an investigation of the disaster and its repercussions on Sweden with the heads of Nuclear Power Inspectorate, SKI, the Radiation Protection Agency, SSI, the Environmental Protection Agency, SNV, and the National Institute for Economic Research, KI, as members.

After four months, by the end of October, this commission presented its report entitled *After Chernobyl. Consequences for energy policy, nuclear safety, radiation protection and environmental protection.* It concluded that the Chernobyl accident did not change the earlier assessment that it was extremely unlikely that an accident with radioactive releases of similar magnitude would happen during the Swedish nuclear programme even if it could not be totally excluded. The commission further argued that an immediate phasing out of nuclear power would have severe economic consequences. Based on this report Birgitta Dahl and her advisors made a Bill to Parliament in which she proposed a start of the phasing out of nuclear power in the mid-1990s; a first reactor would be decommissioned 1993–95 and a second in 1994–96. After additional investigations about the exact timing of the phase out, Dahl proposed a new Bill in 1988, with a phase out of the first reactor in 1995, and the second in 1996. After Parliament had approved this Bill, Dahl emphasized that this decision to start the phase out was irreversible.

The People's Campaign of course urged for a much faster phase out of nuclear power, but two years had passed after the Chernobyl accident and the re-mobilization of the anti-nuclear movement had faded out, thus it didn't have much political weight any more. The new energy policy was instead strongly contested by the more nuclear friendly Conservative Party and Liberal Party and many industrial leaders. More importantly, many leading trade unionists, which traditionally had been a strong faction within the Social Democratic Party, also opposed it. They argued that a "premature phase out" – as they called it – would lead to increased electricity tariffs, which in turn would threaten jobs in industry. In the following year the Party experienced fairly strong internal conflicts that were referred to as the "War of the Roses" (a red rose is the symbol of the Social Democratic Party), between an economic growth-oriented faction around the trade unions, and a more environmentally oriented faction around the youth's and women's organizations of the party. As a result of this conflict the party leader and

Prime Minister Ingvar Carlsson transferred the energy portfolio from Birgitta Dahl to the trade union leader, Rune Molin, who became a member of the cabinet.

Molin started negotiations about a revision of the energy policy with two other parties, the Centre Party and the Liberal Party, and in early 1991 the three parties made an Energy Agreement in which the "premature phase out" of nuclear power in the mid-1990s was postponed to an undefined time. One argument for this new policy had to do with climate change, which had become an important political issue since 1988. Parliament had formulated a goal in 1988 that future emissions of CO2 should not be increased, and this was used as an argument for postponing the phase out. Moreover, as a concession to the Centre Party, which has its traditional base among farmers, the Energy Agreement included a programme for a fast increase of biomass production through subsidies and the introduction of CO_2 taxes. The three parties had a majority in Parliament, and even though there was strong opposition from the new Green Party and the Left Party (former Communist Party) against the postponement of the phase out, this new energy policy was adopted by Parliament in the spring of 1991 (Högselius and Kaijser 2007).

Thus, five years after the Chernobyl disaster Parliament decided to continue the Swedish nuclear programme essentially unchanged. The initial "irreversible" decision to fasten the phase out had been revised after a strong reaction from the pro nuclear side.

Type of event

The Chernobyl accident resulted in a short revival of the anti-nuclear movement, which organized demonstrations and public meetings. There was also an intensive debate in mass media. This in turn led to a political process in government and parliament with two successive reformulations of energy policy. This event has been recognized by earlier research.

Identification of actors

The nuclear industry and regulatory agencies played an important role in disclosing the disaster. In the first months after the disaster, the anti-nuclear movement organized demonstrations but was not able to regain its organizational strength from the referendum campaign and soon faded away again. Scientists, experts, environmentalists, industrialists and intellectuals engaged in an intense mass media discussion about the disaster and its implications for the Swedish nuclear programme. Poll institutes reported a rapid increase in negative sentiments about nuclear power. This all led to a political process within the Ministry for Energy and Environment and Parliament, and later on within the governing Social Democratic Party.

Arguments and behaviours

The anti-nuclear movement argued that the Chernobyl disaster demonstrated the dangers of nuclear power once again (after TMI) and that the phase out should therefore be hastened considerably. The pro nuclear side argued that the Soviet reactors and nuclear industry were totally different from the Swedish, and that an accident like Chernobyl with large radioactive releases was impossible in Sweden. Therefore, they argued, there was no need to revise the nuclear policy. The anti-nuclear side at first organized demonstrations and meetings, but soon most of the process took place in mass media and within the formal parliamentarian political system.

Public engagement

This was mainly a political process on the national level with much communication in mass media.

Event 5: A competition for getting a repository

Case history

In the beginning of the 1990s, SKB made a reorientation of its strategy. Previously it had tried to find sites with solid rocks without any cracks, through which water might reach to the surface. But based on more developed safety analyses SKB now started to underline that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts of a multiple barrier system. This reorientation meant that it was no longer necessary to search for the best possible geological location in the whole country, but that the geology in large parts of the country was sufficiently good. Other factors, like the attitude of the local population and the availability of suitable transport and other infrastructural facilities, were as important as geology.

In 1992 SKB sent a letter to all Swedish municipalities with a question if they were interested in a pre-study of a repository starting with test drillings. SKB emphasized that the process would be based on voluntariness and that no municipality would be forced to accept spent fuel against its will. Eight municipalities in northern Sweden responded positively and two of these were chosen by SKB for pre-studies, Storuman and Malå. These were both municipalities with high unemployment and a future repository, which was estimated to generate

350 jobs for 50 years, seemed as a very attractive option to local politicians. Existing geological data, e.g. from prospecting for mines, were analysed in detail, and also other conditions were assessed. SKB concluded that both places could be suitable for a repository. However, local opposition had emerged in both places and it became so strong that the local politicians in both places decided to organize a local referendum. In both places a clear majority voted against a future repository (Lidskog 1998).

In 1996 SKB organized a conference in Stockholm with researchers and directors from nuclear companies in 23 European countries all sharing the same problem with local resistance to repositories. This led SKB to focus on municipalities that already had nuclear plants (Anshelm 2006a). Preliminary studies indicated that two of these, Östhammar (where Forsmark is located) and Oskarshamn, had the best conditions with inhabitants that were familiar with nuclear facilities and with suitable infrastructure. In 2002 more thorough studies of these two municipalities commenced including test drillings to investigate if the rock was acceptable. The ensuing process was very different from previous attempts. Instead of having to deal with very reluctant local populations, SKB now had two largely positive local populations, and in the following decade something of a beauty contest evolved. The local politicians in both places did their very best to convince SKB about the advantages of their place. SKB arranged a number of meetings and consultations with local people in both places to inform them about how the repository would be built. After a long evaluation process SKB reached the decision in 2009 that Östhammar would be the best place for the future repository for geological reasons. They simultaneously decided that the future plant for constructing copper canisters for the spent fuel would be located next to the existing interim storage facility in Oskarshamn.

Type of event

SKB gradually learned from previous processes and adopted a more open and cooperative attitude towards municipalities, emphasizing that a decision about a repository only would be made if a local municipality was in favour of it. When SKB turned to two municipalities with nuclear power plants both politicians and a large part of the population were favourable to a repository and even a sort of contest emerged between them. This event has been recognized by earlier research.

Identification of actors

SKB was a key actor and had a new attitude towards municipalities. In Storuman and Malå, many local politicians were initially positive to a repository that would give many jobs, but local environmentalists mobilized against it and were able to gain a majority in the local referenda.

In Östhammar and Oskarshamn a clear majority of both politicians and the local population were positive to the plans for a repository and cooperated actively with SKB in the investigations.

Arguments and behaviours

The job argument was important in all the municipalities, but in Storuman and Malå the environmental dangers with a repository became the dominant argument. In Östhammar and Forsmark the population was already accustomed to nuclear facilities and had a trust in the nuclear industry. This implied that no strong opposition emerged. On the contrary, the job argument became dominant and the municipalities engaged in a sort of contest for the repository.

Moreover, SKB started to underline that the rock itself was not the single most important barrier but that the other components in a repository, the copper canister surrounded by bentonite clay, also were crucial parts of a multiple barrier system. Thus, it was not necessary to find the perfect rock, only one that was good enough. SKB realised that local acceptance of a repository was a factor of crucial importance in the choice of location.

Based on the negative experiences from the 1980s, SKB adopted an open and cooperative attitude towards the municipalities. During all steps of the revised site selection process they involved the local populations in the communities studied in dialogues of various kinds.

Public engagement

SKB strived to engage the local populations in their studies. In the two northern municipalities, this strategy failed in the end, but in the two municipalities which already had local power plants, the strategy was successful and many locals were actively involved in deliberations. When SKB made the decision to locate the repository in Östhammar the large majority of the local population saw it as a positive outcome for the community.

Facts & Figures

Data summary

After a referendum in 1980, Swedish Parliament decided to phase out nuclear energy by the year 2010, but this decision was later changed and today there are eight operating reactors that generate 40% of Swedish electricity.

Key dates and abbreviations

Key dates

1947	Atomic energy research organization, AB Atomenergi, is established
1954	R1, a research reactor built in Stockholm, starts operation
1956	Government decision about an ambitious programme, The Swedish Path, to create a domestic nuclear fuel cycle, with uranium exploitation, HWR reactors and a reprocessing plant enabling atomic weapons
1960	Two research reactors completed at AB Atomenergi's research station in Studsvik
1964	The Ågesta HWR reactor starts operation
1965	OKG signs a contract with ASEA about the Oskarshamn 1 LWR
1969	AB Atomenergi and ASEAs nuclear division merge into ASEA-Atom
1970	The Marviken HWR reactor is completed but not taken into operation for security reasons, Sweden joins the Non Proliferation Treaty and the "Swedish Line" is definitely abandoned.
1972	O1 is inaugurated.
1974–75	Four more reactors are inaugurated.
1976	Nuclear power is a key topic in the election campaign. The Centre Party leader Thorbjörn Fälldin, who has a clear anti-nuclear stance, becomes Prime Minister.
1977	The Stipulation Act is introduced, which stipulates that reactor owners have to show that the spent fuel can be stored in a totally safe way.
1979	The TMI accident leads to a decision to organize an advisory referendum on the future of nuclear power.
1980	The pro nuclear lines win the referendum and Parliament decides that 12 reactors shall be used until 2010, when all nuclear power shall be phased out.
1985	The 11th and 12th reactors are inaugurated.
1986	The Chernobyl accident affects Sweden substantially.

1992 An incident occurs in the cooling system of the Barsebäck 1 reactor. SKI stops it and four other reactors with the same design until it has been fixed.
1999 The Barsebäck 1 reactor is phased out.
2005 The Barsebäck 2 reactor is phased out.
2009 SKB decides to choose Östhammar as location for a future repository
2010 Parliament vote to repeal the policy to phase out the nuclear energy and to make it possible to build additional reactors at existing nuclear power plants.
2015 The owners of Oskarshamn and Ringhals decide to close down two reactors each by 2020 for economic reasons

Abbreviations

SKI	Swedish Nuclear Power Inspectorate
SSI	Swedish Radiation Protection Institute
SSM	Swedish Radiation Safety Authority
IAEA	International Atomic Energy Agency
WNA	World Nuclear Association

Map of nuclear power plants

Map 1 represents a map of nuclear power sites in Sweden.

Source: WNA 2019

List of reactors and technical, chronological details

Tables below show the list of reactors, operators as well as date details.

Table 1 - Operational and shutdown nuclear power reactors in Sweden

No.	Name	Operator	Type	Mwe net	Construction began	Grid power	Shutdown	Status	Use
1	Agesta	AB SVAFO	PHWR	10	1957	1964	1974	Permanent shutdown	Commercial
2	Barsebäck-1	Barsebäck Kraft AB	BWR	600	1971	1975	1999	Permanent shutdown	Commercial
3	Barsebäck-2	Barsebäck Kraft AB	BWR	600	1973	1977	2005	Permanent shutdown	Commercial
4	Forsmark-1	Forsmark Kraftgrupp	BWR	984	1973	1980		Operational	Commercial
5	Forsmark-2	Forsmark Kraftgrupp	BWR	1120	1975	1981		Operational	Commercial
6	Forsmark-3	Forsmark Kraftgrupp	BWR	1167	1979	1985		Operational	Commercial
7	Oskarshamn-1	OKG	BWR	473	1966	1971		Operational	Commercial
8	Oskarshamn-2	OKG	BWR	638	1969	1974	2015	Permanent shutdown	Commercial
9	Oskarshamn-3	OKG	BWR	1400	1980	1985		Operational	Commercial
10	Ringhals-1	Ringhals AB	BWR	881	1969	1974		Operational	Commercial
11	Ringhals-2	Ringhals AB	PWR	807	1970	1974		Operational	Commercial
12	Ringhals-3	Ringhals AB	PWR	1063	1972	1980		Operational	Commercial
13	Ringhals-4	Ringhals AB	PWR	1118	1973	1982		Operational	Commercial
	R1					1954	1970	Dismantled	Research
	R2	Studsvik AB					2005	Dismantling by 2019	Research
	R2-0					1960	2005	Dismantling by 2020	Research
	R4		heavy water	140	cancelled				Research

Sources: IAEA 2014, WNA 2016

References

Nuclear power and nuclear weapons have been issues high on the political agenda in Sweden for more than half a century. This means that it has attracted much interest not only from historians but also from social scientists, not least from political scientists. It also implies that there is very much official material in the form of reports from government commissions, government bills, and discussions in Parliament etc. In addition, there is material produced from the various stakeholders to be used in debates for and against nuclear power or nuclear weapons. (It is sometimes difficult to make a distinction between "research" and "debate publications"). Moreover, much of the media coverage of the nuclear history is becoming easily accessible thanks to the digitalization of major Swedish daily journals and the public service TV and radio. All this means that it is difficult to get an overview of all the material, and the list below does not pretend to be exhaustive. It includes some of all the categories above, with an emphasis on historical research and political science research.

Within the Swedish part of the HoNEST project eight interviews have been made with some of the key actors, and these interviews are also included in the list below.

Research publications

Agrell, Wilhelm. 1999. *Övrig illegal verksamhet. Övervakning av svenska kärnvapenmotståndare* 1958–1968. Stockholm: Wahlström & Widstrand.

——. 2002. *Svenska förintelsevapen. Utveckling av kemiska och nukleära stridsmedel 1928–70.* Lund: Historiska Media.

Andrén, Mats, and U. Strandberg, eds. 2005. *Kärnavfallets politiska utmaningar.* Hedemora: Gidlunds.

Anshelm, Jonas. 2002. *Mellan frälsning och domedag. Om kärnkraftens politiska idéhistoria i Sverige 1945–1999.* Stockholm: Symposion.

——. 2006. *Bergsäkert eller våghalsigt? Frågan om kärnavfallets hantering i det offentliga samtalet i Sverige 1950–2002.* Lund: Arkiv förlag.

——. 2006. *Från energiresurs till kvittblivningsproblem. Frågan om kärnavfallets hantering i det offentliga samtalet i Sverige 1950–2002.* Stockholm: SKB.

——, and Vasilis Galis. 2011. "(Re-)constructing Nuclear Waste Management in Sweden: The Involvement of Concerned Groups." In Kumar, Surin (ed.). *Integrated Waste Management, vol. II,* ed. by Surin Kumar, 401–430. Rijeka: InTech Open.

——. 2009. "The politics of high-level nuclear waste management in Sweden: on confined research vs. research in the wild." *Environmental Policy and Governance* 19:269–280.

Bjurling, O. 1981. *Sydkraft Samhälle.* Malmö: Sydkraft.

Brynielsson, Harry. 1989. "Utvecklingen av svenska tungvattenreaktorer". *Daedalus. Tekniska museets årsbok,* 199–228.

Fjæstad, Maja. 2010. *Visionen om outtömlig energi: bridreaktorn i svensk kärnkraftshistoria 1945–80.* Hedemora: Gidlunds förlaga.

——, and Thomas Jonter. 2010. "Between Welfare and Warfare: The Rise and Fall of the 'Swedish Line' in Nuclear Engineering." *Science for welfare and warfare: Technology and state initiative in cold war Sweden,* ed. by Per Lundin, Niklas Stenlås, and Johan Gribbe. Sagamore Beach, MA: Science History Publications.

——. 2008. "Demokratins triumf eller fiasko? Folkomröstningen om kärnkraft i retroperspektiv." *Dædalus. Tekniska museets årsbok*, 64–75.

Fridlund, Mats. 1999. *Den gemensamma utvecklingen. Staten, storföretaget och samarbetet kring den svenska elkrafttekniken.* Stockholm: Symposion.

Gimstedt, Olle. 1990. "Oskarshamnsverket 1 – En pionjärinsats i svensk kärnkraftutbyggnad." *Daedalus. Tekniska museets årsbok*, 235–271.

Glete, Jan. 1983. *ASEA under hundra år.* Västerås: ASEA.

Holmberg, Sören et al., eds. 1977. *Väljarna och kärnkraften.* Stockholm: Liber.

Holmberg, S., and K. Asp. 1984. *Kampen om kärnkraften – en bok om väljare, massmedier och folkomröstningen 1980.* Stockholm: Liber.

Högselius, Per, and Arne Kaijser. 2007. *När folkhemselen blev internationell. Elavregleringen i historiskt perspektiv.* Stockholm: SNS.

Jasper, James M. 1990. *Nuclear Politics – Energy and the State in the United States, Sweden, and France.* Princeton: Princeton University Press.

Jonter, Thomas. 2002. *Nuclear Weapon Research in Sweden. The Cooperation Between Civilian and Military Research, 1947–1972.* Stockholm: SKI Report 02:18.

——. 2002. *Sweden and the Bomb. Swedish Plans to Acquire Nuclear Weapons, 1945–1972.* Stockholm: SKI Report 01:33.

——. 2016. *The Key to Nuclear Restraint. The Swedish Plans to Acquire Nuclear Weapons During the Cold War.* London: Palgrave Macmillan.

——. 1992. "Redirecting Power: Swedish Nuclear Power Policies in Historical Perspective." *Annual Review of Energy and the Environment* 17: 437–462.

——. 2001. "From tile stoves to nuclear plants: The historical development of Swedish energy systems." In *Building sustainable energy systems: Swedish experiences*, ed. by Silveiera Semida, 57–93. Stockholm: Svensk byggtjänst.

Larsson, Karl-Erik. 1987. "Kärnkraftens historia i Sverige." *Kosmos* 121–161.

——. 1981. "Kärnreaktorn R1 – ett stycke högteknologisk pionjärhistoria." *Dædalus. Tekniska museets årsbok*, 105–120.

Leijonhufvud, Sigfrid. 1984. *Parentes? En historia om svensk kärnkraft.* Västerås: ABB Atom.

Lidskog, Rolf. 1994. *Radioactive and Hazardous Waste Management in Sweden.* Stockholm: Almqvist & Wicksell.

Lidskog, Rolf, ed. 1998. *Kommunen och avfallet.* Stockholm: Carlssons.

Lindström, S. 1991. *Hela nationens tacksamhet – Svensk forskningspolitik på atomenergiområdet 1945–1956.* Stockholm: Department of Political Science, Stockholm University.

Lindqvist, Per. 1997. *Det klyvara ämnet. Diskursiva ordningar I svensk kärnkraftspolitik 1972–1980.* Lund: Department of Sociology, Lund University.

Lönnroth, Mans, Thomas B. Johansson, and Peter Steen. 1978. *Sol eller Uran – Att välja energiframtid.* Stockholm: Liber.

Lundgren, Lars. 1978. E*nergipolitik i Sverige, 1890–1975.* Stockholm: Secretariat for Futures Studies.

Moberg, Leif. 2001. *Kärnkraftsolyckan i Tjernobyl. En sammanfattning femton år efter olyckan* (SSI-report 2001:07). Stockholm: SSI.

Schagerholm, Annki. 1993. *För het att hantera: Kärnkraftsfrågan i svensk politik 1945–1980.* Gothenburg: Department of History, Gothenburg University.

Statens Vattenfallsverk. 1984. *Vattenfall under 75 år.* Stockholm: Vattenfall.

Storm, Anna. 2014. *Post-industrial Landscape Scars.* London: Palgrave Macmillan.

Vedung, Evert. 1979. *Kärnkraften och regeringen Fälldins fall.* Uppsala: Rabén och Sjögren.

Wittrock, Björn, and Stefan Lindström. 1984. *De stora programmemens tid – Forskning och energi i svensk politik.* Stockholm: Akademilitteratur.

Debate publications

Alfvén, Hannes. 1975. *Kärnkraft och atombomber.* Stockholm: Aldus förlag.

Bergström, H., and J. Larsson. 1979. *Använd våra kärnkraftverk.* Stockholm: Liber.

Björnerstedt, R. 1965. *Sverige i kärnvapenfrågan.* Stockholm: Folk och försvar.

Eriksson, Björn et al., eds. 1982. *Det förlorade försprånget.* Stockholm: Miljöförbundet.
Fogelström, Per Anders, and Roland Morell. 1958. *I stället för Atombomb.* Stockholm: Bonniers förlag.
Kjellström, Björn, and Per Kågeson. 1979. *Rösta Nej!.* Stockholm: Liber.
Kågeson Per, and Björn Kjellström. 1984. *Fängslad vid kärnkraft?.* Stockholm: Liber.
Kågeson, Per 1973. *Stoppa kärnkraften!.* Stockholm: Prisma.
Moberg, Åsa 2014. *Ett extremt dyrt och livsfarligt sätt att värma vatten. En bok om kärnkraft.* Stockholm: Natur och kultur.
Sköld, Per Edvin, ed. 1959. *Svenska atomvapen. Sex fackmannauppsatser.* Stockholm: Tiden.

Publications from government

Some important Government Energy Bills:
Prop. 1975:30. *Energihushållning m m.*
Prop. 1978/79:115. *Riktlinjer för energipolitiken.*
Prop. 1980/81:90. *Riktlinjer för energipolitiken.*
Prop. 1987/89:90. *Energipolitik inför 1990–talet.*
Prop. 1990/91:88. *Energipolitiken.*

Reports from important government commissions:
SOU 1956:11. *Atomenergien* (Atomenergiutredningen).
SOU 1970:13. *Energipolitik och organisation* (Energikommittén).
SOU 1974:56. *Närförläggning av kärnkraftverk* (Närförläggningsutredningen).
SOU 1974:64. *Energi 1985–2000* (Energiprognosutredningen).
SOU 1978:17. *Energi* (Energikommissionen).
SOU 1979:83. *Om vi avvecklar kärnkraften* (Konsekvensutredningen).
SOU 1979:86. *Säker kärnkraft?* (Reaktorsäkerhetsutredningen).
SOU 1984:61. *Istället för kärnkraft* (Energikommittén).
SOU 1995:139. *Omställning av energisystemet* (Energikommissionen).
Dsl 1978:11. *MALTE 1990. Förslag till miljörörerelsens alternativa energiplan.*
Dsl 1986:11. *Efter Tjernobyl. Konsekvenser för energipolitik, kärnkraftsäkerhet, strålskydd och miljöskydd.*
Industridepartementet 1970. *Svensk atomenergipolitik. Motiv och riktlinjer för statens insatser på atomenergiområdet 1947–1970* ("Vitboken").

Digital sources

World Nuclear Agency. *Nuclear Power in Sweden.* 2016 (update 2019). Accessed 28 June 2019. https://www.world-nuclear.org/information-library/country-profiles/countries-o-s/sweden.aspx
IAEA Country Nuclear Power Profiles. 2014. Accessed 30 June 2016. https://cnpp.iaea.org/countryprofiles/Sweden/Sweden.htm

Interviews made in the HoNEST project in April to June 2016
Carl Tham, Minister of Energy 1978–1979.
Alf Lindfors, Former CEO of the Forsmark Nuclear Power plant.
Mats Odell, Representative of the Christian Democrats in the People´s Campaign against Nuclear Power.
Per Kågeson, Author of several influential books and leading anti-nuclear activist.
Leif Josefsson, Former CEO of the Barsebäck Nuclear Power Plant.
Lennart Daleus, Campaign general for the anti-nuclear side in the nuclear referendum in 1980.
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