Nuclear power in societal flux: the renewal of nuclear power in Finland in the context of global concern over energy security

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Abstract: This paper will address nuclear power's relationship with societal flux. The history of nuclear power indicates that this type of technology is unusually sensitive to societal flux. Instability in nuclear power's societal status is created by the ambiguous nature of the technology itself, changing public opinion, the fluidity of political judgments, the flow of cultural meanings attaching to nuclear power and the unpredictability of media processing. Even though the risks of nuclear technology are highly regulated by the companies themselves and by the state and public administration, it remains capable of inflaming political debate and igniting controversy. One public opinion survey after another reveals how divisive nuclear power is. Unlike most other industrial activities nuclear power decision-making involves extraordinary levels of political consideration, societal processing and cultural valuation by stakeholders and the media. In order to illustrate the idea of societal flux, the paper will deal with major shifts in Finnish nuclear power policy since the 1950s, focusing particularly, however, on changes between 1986–2010. The recent changes in the country's nuclear power policy prove interesting having proceeded from a phase of rejection during the period 1986-1993, to a revival between 1994-2002 and renewal between 2002-2009. The rejection period ended in 1993 during which time the Parliament of Finland had rejected the further construction of nuclear power plants in the wake of the Chernobyl accident. In less than a decade, however, nuclear power policy changed. The revival period ended in 2001 as Parliament ratified a Decision in Principle for the final disposal of spent nuclear fuel and in 2002 for the construction of a new nuclear power plant unit, Olkiluoto 3. Characteristic of the ongoing renewal period is that in 2008–2009 the nuclear industry submitted three further applications for the construction of new NPP units. Thus Finland today has acquired a reputation for being a pioneer in implementing the final disposal of spent nuclear fuel and in the new build of nuclear power technology.

Keywords: nuclear power; societal flux; Finland; nuclear power policy

1 Introduction

What is societal flux and how should we define it? A starting point would be to refer to current nuclear political rhetoric. Recently many authors have referred to a so-called nuclear renaissance[1,2], nuclear revival[3,4] or nuclear renewal[5],[6] when describing the ongoing political rise of nuclear energy. Behind the term nuclear renaissance is acknowledgement of the fact that the nuclear power industry's expansion has gained new political opportunities thanks to globally increasing energy demand, the globalization of industry and commerce and international efforts to combat climate change[7].

2 Enthusiasms and anxieties at the dawn of nuclear power

When we compare this new rhetorical turn in the nuclear power debate with earlier periods it becomes evident that the same optimistic rhetoric has existed since the dawn of the nuclear age. To illustrate this, Spencer Weart's[8] analysis of the imagery of the history of nuclear energy reveals how the development of nuclear science is intertwined with rhetoric, symbolism, emotions and cultural values. The early history of nuclear power begins in 1896, with the discovery of radioactivity. At first it attracted scant attention. As Weart[9] neatly describes it:

"It seemed only a curiosity that a few minerals such as thorium and uranium emitted feeble rays resembling a sort of invisible light. Then Marie Curie discovered the new metal radium, whose rays, compared with the whisper from uranium, were like a piercing shout."

Cultural awareness of this new innovation began to spread as Marie Curie and her husband Pierre demonstrated their innovation by "displaying little vials of radium compounds so active that they glowed with a pearly light" at the world physicists conference

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in Paris in 1900. Newspapers began to pay attention to radioactivity. Gabrielle Hecht[10], the author of "The Radiance of France" emphasizes that before World War II, Marie and Pierre Curie and their colleagues became national heroes in France thanks to their Nobel prizes in physics and chemistry.

Nevertheless Marie and Pierre Curie were not themselves the messengers of this new scientific victory, but Frederic Soddy and Ernest Rutherford. As chemists investigating radioactivity, they discovered in 1901 that radioactivity is a sign of fundamental changes within matter: a pulse of radiation signals that an atom is transforming into a different kind of atom; a different element with its own chemical properties[11]. Just as the two scientists celebrated their discovery in the laboratory in joyful and optimistic tones, from that moment onwards, strong positive and negative emotions have been part of the history of nuclear power.

The fateful enthusiasm for nuclear energy that swept the world during the first half of the twentieth century was not a consequence of the facts of physics, as Weart[12] explains. To understand this triumph of science we have to pay attention to culture and cultural agents. Weart's sophisticated analysis indicates how cultural elements which were already present in earlier centuries coalesced in the case of nuclear science due to the efforts of scientists themselves and of journalists.

Besides Soddy and Rutherford other evangelists for science stepped forward such as French scientists Gustave Le Bon and Marcelin Berthelot. All of these moral entrepreneurs utilized the media to spread the good news of nuclear energy. As early as 1903 Soddy explained in a British magazine that radioactivity represents inexhaustible power and that matter must be considered as a storehouse of energy. During his journey to Australia to lecture he summarized the findings by saying that a pint bottle of uranium contains enough energy to drive an ocean liner from London to Sidney and back. His contemporary the French chemist Marcelin Berthelot declared that the earth would be a garden where a kinder and happier humanity would live amid the abundance of a Golden Age in which the discoveries of science would provide a limitless source of energy. A very concrete example of this scientific victory was the Chicago International Exposition of 1893 when the so called White City was lit at night with new electric lamps powered by steel dynamos. Enthusiasm for the scientific future was also present in Gustave Le Bon's popularization of radioactivity when he explained that once people learn to use its energy "The poor will be equal to the rich and there will be no more social problems."[13].

This strong enthusiasm around radioactivity however was also accompanied by fears, concerns and distrust. As Weart [14] explains, right from the beginning of the nuclear age, radioactivity was associated with the idea of atomic weapons and the end of the world. For instance, in 1903 both Soddy and Le Bon educated the public about the other side of the coin. They both described the radioactive devices that could "… cause the earth to revert to chaos" and "blow up the whole earth" [15]. These kinds of popularizations of radioactivity and atoms made a massive impact on the public. They served as symbols which reflected rising anxieties about the anticipated technological future.

Following Weart we can say that over the course of a century the imagery of nuclear energy has consisted not only of positive and optimistic symbols and meanings but also of dark, pessimistic and fearful images. Apocalyptic visions of doomsday created by mad scientists are images as permanent as those of a peaceful and prosperous Golden Age or new Eden of humankind. The brilliance of Weart's analysis is that he shows how the pessimism around nuclear energy has been an essential part of nuclear culture from the earliest stages of scientific progress. From grounding in historical data he convincingly shows how news of Hiroshima and Nagasaki and reports from the atmosphere testing of nuclear bombs did not change the ambiguous nature of nuclear energy. The cultural values attaching to nuclear energy had been there as early as the beginning of the 20th century.

3 Ebbs and flows in nuclear energy

The appearance of an upswing in nuclear power logically implies something that has not always been at this level. As noted earlier, nuclear energy has experienced a form of global downturn, recession, stagnation or stabilization which has been evident for

decades[16]. A typical way to interpret nuclear energy's future has been to refer to how in many countries nuclear power programmes have been winding down or have been halted. For instance Wolfgang Rüdig[17] starts his massive and amazingly rich book on global anti-nuclear movements with the description of the nuclear energy:

"The development of nuclear energy could enter history as one of the most spectacular failures of human enterprise ever recorded. Less than 20 years ago, nuclear energy was universally regarded as the technology of the future which was expected to revolutionize almost every aspect of human existence. With the oil crisis threatening Western energy supplies in the early 1970s, ambitious plans for the nuclear expansion were set in motion all over the world. The inevitability of an all-nuclear energy future was almost universally accepted: it was only what then appeared to be mavericks, outsiders and utopians who opposed the move to the brave new nuclear world.
By the late 1980s, we can observe an almost complete turnaround in the fortunes of nuclear power. Public opinion throughout the Western world is more anti-nuclear than ever before. Most industrialized countries have halted their nuclear programmes or abandoned nuclear energy altogether. Now, the view of the inevitability of nuclear energy is regarded almost as maverick as anti-nuclear protest 20 years ago."

Another way to prophesy nuclear energy's future has been to say that it is only a short or medium term solution. Reasons for nuclear stagnation were seen in serious nuclear accidents such as a fire at the Windscale plutonium production plant in the UK in 1957, the Three Mile Island accident in the USA in 1979 and the Chernobyl accident in 1986. Other reasons for stagnation were seen in economic and social issues, e.g., privatisation in the UK meant economic problems for the nuclear industry[18] and public opposition to nuclear power was high due to burgeoning environmental movements and heightened awareness in the 1970s and 1980s[19]. To illustrate how nuclear power was perceived at the beginning of the 1990s we can quote van Heijden, *et al.*[20]: "Further, with the resolution of the nuclear energy conflict, which has in many countries ended in a victory for the movements, the issues at stake seem to have become increasingly consensual." Elliot[21] put it differently by writing that "Concerns about safety, security and economics have led to a decline in enthusiasm for the nuclear option in some, but not all, countries."

Once again the timing of this 'downturn' is difficult. Some authors see the decline in the civilian use of nuclear energy starting as early as the 1960s. For instance Weart[22] describes how news of the hydrogen bombs, intercontinental missiles, atmospheric testing of atomic bombs and fallout from bomb tests broke down the symmetry of hopes and fears in the early 1960s. Golden promises could no longer balance nuclear fears. Distrust of the nuclear authorities was followed by a rising anti-nuclear power movement in the 1970s[23],[24]. It brought severe problems for the civilian nuclear industry. Already from 1945 there had been openly political groups, such as liberal atomic scientists, pacifists, world federalists, civil defence officers, communist propagandists, Air Force officers and military industrialists, who, all with their different reasons tried to tame the public fear of nuclear weapons. From the mid-1950s on, the promotion of fear and distrust towards nuclear weapons industry, nuclear authorities and civilian use of nuclear power began [25]. One historical milestone for the anti-nuclear power movement was the first case of sustained public opposition to a reactor in the United States during 1956[26]. The opposition increased even though the period was dominated by enthusiasm. Flam & Jamison[27] describe how anti-nuclear activism began in Sweden in the late 1960s in the form of a small Working Group against Atomic Energy to oppose one of the world's most ambitious nuclear energy programmes in relation to its population size.

When studying the Western European environmental movement Heijden, *et al.*[28] want to include the anti-nuclear movement within the environmental movement, because linkages between these movements were markedly strong and the resistance to nuclear energy was the major issue for the Western European environmental movement. For these investigators the timing of the origin of the resistance against nuclear energy is fairly straightforward even

though they emphasize national differences. They see the anti-nuclear power movement emerging during the first half of the 1970s and the most substantial confrontations taking place around the end of that decade. At the beginning of the 1980s the resistance to nuclear energy waned and in many countries activists switched from opposing nuclear energy to opposing nuclear weapons when mass demonstrations against the deployment of Cruise missiles started in several West European countries[29]. Also in this case we have to take into account national variations in the life-cycle of the anti-nuclear power movement. For instance in Germany there were massive campaigns against the planned reprocessing plant in Wackendorf and the reactions to the Chernobyl accident produced a new peak of activities[30].

The oil crisis in 1973 and subsequent economic crises in Western industrialized countries temporarily accelerated the adoption of nuclear energy in industrialized countries, but at the end of the 1970s a change of political wind halted the expansion of the nuclear industry in many developed countries. Nevertheless some countries continued their nuclear programs even during the difficult years of the 1970s and 1980s. Rüdig[31] has documented France as an exception in Western Europe, with Japan, South-Korea and China in the Far-East. There was also interest in nuclear power in Eastern Europe during those decades.

James Jasper[32] indicates how the oil crises in 1973 opened huge opportunities for the growth of the nuclear industry, but with different outcomes in the United States, Sweden and France. Only France was able to continue its massive deployment of nuclear energy. The United States was unable to complete even the reactors that had been ordered or that were under construction in 1973. Sweden was between these two extremes as it added ten reactors to the two operating in 1973, but the Swedish government committed itself to shutting down all twelve reactors by the year 2010. Divergence of these three nuclear programs is clear: triumph of one, collapse of the second and curtailment of the third.

In his article Jasper[33] describes how the relatively non-political nature of nuclear policy changed in October 1973, when the Arab oil-producing countries started their oil embargo to send a very strong message that they did not accept the favouring of Israel by the advanced industrialized countries during the Arab-Israeli war. A resurgence in support for nuclear power was evident. The political flood-gates were open for the expansion of nuclear power in all three countries - the United States, Sweden and France - which Jasper analyzes. However, the appearance of a revival of nuclear power turned out wrong. Intervening factors, such as more open and democratic debate on energy policy, rising environmental concern, domestic political disputes and changing political agendas produced different outcomes in the different countries Jasper studied.

During the recession period in nuclear power some authors[34,35] regard nuclear technology as the very incarnation of the pre-1970s politico-economic constellation which does not well fit in post-industrial society. They view nuclear power as the epitome of standardized mass-production. The problem identified by the authors is that nuclear power plants produce only electricity, whilst losing much primary energy and promoting energy consumption rather than its savings.

The rising anti-nuclear movement of the 1970s challenged both the nuclear industry and the state, which had an important role in safeguarding the planned nuclear programs. For instance in Sweden and Austria anti-nuclear movements succeeded in halting their nuclear programs. After the referendum on nuclear power in Sweden in 1980 the Swedish Parliament approved a plan to phase out nuclear power plants by 2010. Today we know that the prediction by Flam and Jamison[36] was correct: “It is thus only reasonable to assume that the phasing out nuclear energy in Sweden by 2010, not to mention the closing of the first reactor in 1995, is far from certain.” One outcome of the Swedish phase-out programme was the closing of the two Barsebäck units, both 600 MWe boiling water reactors, in 1999 and 2005. But closing down all other 10 reactors is far from a reality. This year, on 17 June 2010, the Swedish Parliament adopted a decision allowing, starting from 1 January 2011, a replacement of the existing reactors with new nuclear reactors.

Another interesting case is Austria, where the anti-nuclear movement succeeded in stopping the development of the nuclear industry completely[37]. After the referendum in 1978 the Austrian Parliament unanimously passed the Nuclear Energy Prohibition Act and in 1997 the Austrian Parliament unanimously passed legislation to remain an anti-nuclear country.

4 Nuclear power in societal flux in Finland

A country's history of nuclear power is also able to indicate the societal fluctuation of nuclear power. Before going into recent nuclear power debates and decision-making in Finland, let me briefly describe the present state of affairs. Today Finland has two nuclear power plants (NPP) with four nuclear reactors providing nearly 30% of its electricity and a fifth is under construction. Just in the beginning of July this year 2010 the Parliament accepted two new applications meaning that in the future Finland will have seven NPPs.

At the moment there are three nuclear power companies in Finland. Teollisuuden Voima Oy (TVO) owns two boiling water reactors supplied by the Swedish company Asea Atom. Fortum Power and Heat is the owner of two modified Russian pressurized water reactors (VVER) with Western containment and control systems. These two older nuclear power plants consisting of four reactors were connected to the grid in the late 1970's and at the turn of that decade. The newest one, owned by TVO, is expected to be in operation in 2012. The third nuclear power company, Fennovoima Oy, was established in 2007. It is a consortium of industrial and energy companies aiming to construct a new nuclear power plant in Finland.

The early history nuclear power in Finland was characterized by a similar enthusiasm or euphoria as was the case in other industrialized countries aiming to develop nuclear power. The real problems only came when it was decision-making time. Political decision-making became painful on the first nuclear power plant due to Finland's great societal passions. As a small country caught between two Great Powers, United States and Soviet Union, Finland could not order its nuclear power plant whilst completely ignoring the tense political relations between the Great Powers. Received political wisdom in the 1960s was not to irritate the country's large neighbour, the Soviet Union. This produced a multi-act political play which ended with the decision to allow the state-owned company to order the first nuclear power plant from the Soviet Union, but to allow private industry to order their plant from the west a little later[38]. Nuclear power decision-making was not only a question of technology policy, but also a question of geopolitics and international relations.

In a recent article manuscript we analyzed the recent history of nuclear power in Finland[39]. We divided the nuclear power debate into three different periods: 1) the rejection period 1986-1993, 2) the revival period of 1994–2002 and 3) the renewal period 2003–2009. The rejection period 1986-1993 is characterized by strong antagonism between the anti-nuclear coalition and the pro-nuclear coalition. The anti-nuclear coalition was able to challenge the supporters of nuclear power as the Chernobyl accident made the political parties more sensitive to public opinion. In September 1993 Parliament rejected the application of the nuclear power company by 107 votes to 90. When the anti-nuclear movement won this round, the dissolution of the coalition began.

During the revival period of 1994–2002 the pro nuclear coalition was even more determined and united to push the further construction of nuclear power into the political agenda in order to gain a positive decision. Political acceptance of the idea of the further construction of nuclear power was greater than during the earlier period. One reason for this was that nuclear power was defined as a low-emission and technically or economically viable mode of production that could support environmental and climate objectives. This period ended with the victory of the pro-nuclear coalition in May 2002 when Finland's parliament voted 107-92 to approve building a fifth nuclear power reactor.

The latest, renewal period 2003–2010, is characterized by an internally divided, even competitive, supporting coalition. A completely new power company, Fennovoima, has challenged the older two. All three nuclear power companies send their applications to the government. Fortum's application for a

decision-in-principle on the construction of a new unit at Loviisa was rejected by the government in April 2010. After intense debate, Finland's parliament approved construction of the TVO reactor by 120 votes to 72, and one Fennovoima reactor by 121 to 71.

There are several reasons for the rejection of Fortum's application. At the general level one could say that the public image of the company had not been very positive. Even though the state is a majority shareholder in Fortum (50.8 % at 31.12.2009) and the company is listed on the Helsinki stock exchange, the company has faced significant PR-problems during the last decade. A publicly listed company is run on commercial principals, meaning that politicians are unwilling to interfere in the management of the company. Fortum has managed to accrue huge profits from its dominant position in the electricity markets and has gathered windfall profits from its use of nuclear and hydroelectric power, which produce no CO_2 emissions. The success of the company has meant that its generous stock option programmes rewarded the managers of the company with millions of Euros per year. These awards to managers aroused consumer anger as the price of electricity continued to rise despite increasing company profits. Negative publicity for Fortum was the main reason for the early retirement of the former CEO Robert Lilius at age 60 at the end of 2009. Meanwhile decision-making time for nuclear power was approaching in 2010.

Another reason for the political shunning of Fortum is related to the functioning of the electricity markets. There have been complaints about possible abuse of market power in the electricity market, principally against the joint owners of nuclear plants. The large vertically integrated power producers operating in the Nordic electricity market, namely Vattenfall, Fortum and E.ON are under accusation of abusing their position in the end-user market[40].

In nuclear power decision-making, right-wing Government (a majority coalition formed by the Centre Party, the National Coalition Party, the Green League and the Swedish People's Party of Finland) ministers have followed the recommendations of energy market experts in moves to increase market competition in the common Nordic electricity markets [41,42] For instance, the Ministry of Trade and Industry in its press release of 5 October 2006 emphasized the importance of market competition in the electricity markets thus:

"Safeguarding sufficient electricity supply is essential in order to sustain competition in the electricity market. The oligopolistic structure of electricity production has resulted in a need to restrict the market domination of the largest electricity producers in the Nordic countries. Energy company Fortum's market power should be controlled by re-evaluating its ownership of hydroelectric power plants. The necessary additional power generation capacity would be provided by a new state-owned company whose shareholders would include major electricity consumers and local authorities but not Fortum. Fortum should also relinquish its shareholding in the industry power company Teollisuuden Voima Ltd by selling its shares to independent domestic operators." [43]

These were some of the conclusions given in the administrator's report submitted by Matti Purasjoki, appointed by Minister of Trade and Industry Mauri Pekkarinen in April 2006 to investigate the performance of the wholesale and retail electricity markets.

In order to increase market competition, the administrator called for measures such as allowing a decision on the building of more nuclear power stations, because only by doing so would enough competition be produced. The highly concentrated ownership of nuclear power in Finland had been part of the problem until the stability of the electricity markets started to slide as 64 companies representing trade and industry and dozens of local electricity utilities joined forces in establishing Fennovoima in 2007. It is expected that Fennovoima will bring much-needed competition not only to the domestic market but also to the common Nordic electricity market.

The political driver for Fennovoima is not only that it will bring market competition, but that it is politically important for the ruling right-wing parties to demonstrate how they also serve the interests of the northern part of Finland. Fennovoima will likely build

its nuclear power plant in either Pyhäjoki or Simo. In both these northern Finnish regions there are huge economic issues at stake, which Fennovoima's nuclear power plant will impact upon if located there. The company has announced that during the construction phase alone, the plant will create some 20,000 – 40,000 person work-years in the country, both directly and indirectly. During the use phase, the power plant will directly employ 400–500 people and generate millions of Euros in real estate transactions and income taxes for the local municipality.

TVO, the third nuclear power company, has meanwhile been constructing its new NPP in Olkiluoto, but not without serious problems. As Steven Thomas[44] has stated, the Olkiluoto-3 order was a huge boost for the nuclear industry in general and French Areva NP in particular. Safety approval was given by the Finnish regulator, STUK, in March 2005 and substantive work on-site started in August of the same year. According to Thomas, since then the Olkiluoto-3 project has gone seriously wrong. Thomas describes how since Areva NP has needed a 'shop window' for EPR technology and Olkiluoto-3 would serve as a reference plant for other orders, Areva NP offered the plant on 'turnkey' fixed price terms.

The rising costs of the project have subsequently produced a dispute between the customer and supplier:

"The contract price for Olkiluoto-3 was reported in 2004 to be €3bn for a 1600 MW reactor. Subsequently, the price was reported to be €3.2bn or €3.3bn. By August 2010, Areva NP acknowledged that the estimated cost had reached €5.7bn (an additional €367m was acknowledged in the 2009 accounts), which at the prevailing exchange rate of €1=US$1.35 represented a cost of US$4800/kW. The contract is also the subject of an acrimonious dispute between Areva NP and the customer, Teollisuuden Voima Oy (TVO). Areva NP claims compensation of about €1bn for alleged failures of TVO. TVO, in a January 2009 counterclaim, is demanding €2.4bn in compensation from Areva NP for delays in the project." [45]

Regardless of the global negative publicity of the construction project the company succeeded in getting a positive decision-in-principle from the Government on 6 May 2010, ratified in Parliament on 1 July 2010. The company has announced that it has pressed ahead with Olkiluoto-4 project planning, further licensing and feasibility studies and that after plant-type selection, it will move to project realization including design and preparatory work, civil construction, installations and commissioning. At this rate of progress the unit will be in operation by around 2020.

These recent Finnish nuclear power decisions can be interpreted in the context of energy security. A well-known fact is that Finland's energy mix is diverse and balanced, but that the country is highly dependent on foreign energy supplies. The main fuels imported are crude oil, oil products, coal and natural gas. The country's primary indigenous energy resources are hydro power, wood, wood waste, pulping liquors and peat. Justification therefore for the Government Decision-in-Principle on the Application of Teollisuuden Voima Oyj Regarding Construction of a Nuclear Power Plant Unit, for example, emphasizes national energy security. The official aim is to reinforce the open electricity market whilst ensuring security of supply, maintaining prices at reasonable levels, securing adequate self-sufficiency in production and keeping the environmental impacts of production at an acceptable level[46]. The Government's Decision-in-Principle elucidates this:

"The construction of at most two large nuclear power plant units in Finland increases the supply reliability of electricity over the long term, as domestic production capacity can reduce dependence on the import of electricity. The construction of additional nuclear power would for its part help maintaining the price of electricity at a reasonable level. The Government concludes that the construction of at most two new nuclear power plant units would contribute favourably to the reduction of greenhouse gas emissions and promote the performance of the electricity market."

5 Background factors of cultural-emotional cycles

The first cultural-emotional cycle of strong enthusiasm and optimism offset by fear and scepticism related to nuclear power and the scientific

endeavour behind it characterised the early period of the 20th century. It was ended by the tragedy of the two World Wars. A similar period of enthusiasm followed WW II. Nevertheless, it is important to note that the timing of this second period of enthusiasm is debatable. For instance, Ian Welsh[47] has described the period starting from the end of the 1930s and lasting almost four decades as a period of peak modernity. According to Welsh this period was characterized by strong faith in heroic scientific projects intended to modernize the world. The core element, in different developed societies, of this modernization was nuclear science. This period was followed by a more pessimistic period where nuclear power was no longer hailed as the symbol of the development of civilization and progress of mankind.

When studying this later period Welsh[48] neatly reveals how the pioneers of the earlier period were able to start a scientific movement from the 1940s onwards. Welsh defines this nuclear science movement from the perspective of nuclear science, which constitutes a particular scientific social movement seeking to transform society through the acceptance of particular sets of knowledge claims and the acceptance of its associated social and technical practices. He continues by stressing that nuclear power can thus be regarded as bearer of a particular scientific social movement's views of the desirable or good society. Important for him is to notice that this scientific movement harnesses the dominant cultural values of society to its particular knowledge claims. His argument is that symbolic framing and emotional commitment also operate at the heart of the scientific social movement. Background factors for the success of the nuclear science movement have been the strong belief and faith in progress and betterment through the civil use of the atom.

Nevertheless the nuclear science movement by scientists themselves is not alone powerful enough. As Weart[49] has documented, the role of the mass media has been important since the early steps of nuclear science. What Welsh's[50] analysis adds to this is the importance of the state. He stress that "at the national level nuclear capability became a defining feature of the political, ideological and economic anatomy of both capitalist and socialist states of the 20th century." [51]. In order to respond to the tremendous euphoria and optimism around nuclear technology and fulfil the great promises given by scientists, the scientists needed resources and a reliable partner. Today the investments in scientific research and development are understood as a key instrument to improve national competitiveness, but the history of this development can be traced to the 1950s as the sponsorship of science became a central preoccupation of nation states.

Nevertheless, Jasper[52] emphasizes that it is too simple to search for a single explaining factor behind the fluctuations of nuclear energy. His explanation model consists not only of formal state policymaking dictated by economic calculation, but also structural factors such as market competition, financing mechanisms, bureaucratic autonomy, systems of government and cultural factors such as worldviews, beliefs, rhetoric, symbols, images, ideologies and problem-solving styles. His idea is that cultural factors are intimately connected to political and economic structures[53]. In his analysis of the nuclear politics of the United States, France and Sweden he uses two main cultural factors: ideologies and policy styles. Ideologies refer to explicitly expressed doctrines of political actors. Policy styles are for James Jasper distinct clusters of images, symbols, rhetoric and techniques that an individual or a group can use in thinking about public problems, developing solutions, and persuading others. [54]

Three policy styles Jasper names are interesting: technological enthusiasm, cost-benefit approach and ecological moralism. One particularly interesting technical policy-making style is technological enthusiasm. All three distinct styles are always present in the struggles over nuclear energy. Technologists put trust in technological development, economists trust in the markets and moralists refer to ethical issues and moral beliefs, but we have to remember what Jasper emphasizes[55]:

"… all three carry a confidence and sense of moral purpose. Each group believes its own project could save the world, which others are threatening."

Gabrielle Hecht[56] also applies a fascinating theoretical framework in her study of the societal importance of nuclear power in France. She takes all three elements of politics, culture and technology seriously as objects of analysis. Rather than simply explaining technological development in isolation, she focuses on how politically and culturally determined and conscious are the technical choices. Her idea is that technological development should be treated as social, cultural and political process, which may involve continuity, discontinuity and even disruption. Due to the instability of culture and socio-political changes the technological development is also unstable. Her analysis of the struggle between French gas-graphite nuclear technology and the American light-water system shows how the American technology won, but it was then "made French". To put it in very brief terms, there is societal fluctuation in the status of the technological artefact in question. Or as Hecht[57] puts it, techno-political "regimes are neither static nor permanent: a techno-political regime is easier to topple than the technological system within which it operates."

The outcome of Hecht's analysis is a significant contribution to the history of technology. Her laborious research work documents how the technological identity of the nation and national self-esteem intertwined in France after WWII. The title of the book "The Radiance of France" is fairly equivocal or ambiguous as it refers to the past glory of empire, but also to the reconstruction of the lost greatness of a country which had, during wartime, lost its standing among the powerful countries of the world. In addition to this, the term radiance means radiation in French suggesting that there can be something fearful or harmful in this kind of brilliance, brightness and shine. She demonstrates how the construction of nuclear power technology is not only an aim in itself, but behind it one can trace deliberate political and cultural visions of the development of a country. She reveals how there were, in the field of nuclear policy, two distinct techno-political regimes, which of both consisted of linked sets of people, engineering and industrial practices, technological artefacts, political programmes and institutional ideologies. These regimes acted together to govern technological development and pursue techno-politics. The term techno-politics also illustrates how Hecht[58] perceives technological development not as something inevitably determined by techno-science itself nor by politics, but as a societal process of the "strategic practice of designing or using technology to constitute, embody, or enact political goals." The French nuclear program is for her a techno-political system, a linked network of artefacts, knowledge, and institutions operating in a coordinated fashion toward as series of specified material goals. The components of the nuclear program include state agencies, private companies, reactors, laboratories, uranium mines, university curricula, factories, and portions of the electricity distribution network. [59]

6 Conclusions

The aim of this paper was to demonstrate how the societal flux of nuclear power has been part of this type of technology since the early years of its development. It is characterised by periods of upswing and downswing. Today we are witnessing a boom in nuclear power, but the century-long history of nuclear power, documented in studies that have tracked its societal fluctuation, reveals to us how politically sensitive the issue of nuclear power has been. It is capable of inflaming political controversies and raising large social movements. Its early years in the 20th century were dominated by enthusiasm even though contemporaries debated the darker side of nuclear power. During the history of nuclear power, events such as technological breakthroughs or technological failures have affected the popularity of this form of energy technology. Its inherent nature signals potential risks, dangers and misfortunes, but taming the technology can mean prosperity, wealth and opportunities for peaceful societal development.

Nuclear power is a global issue because it has enough cultural and symbolic power to startle people all over the world. Still, it would be an oversimplification to explain ebbs and flows of nuclear power merely through technological or cultural factors. The recent growing interest in nuclear power needs to be interpreted in the context of global concerns over energy security. The drivers for this are many; the most evident of which is a heightened sense of the vulnerability of the energy supply, concern over the world's energy resources as a precondition of stable

economic growth and climate policy-related requirements to curb emissions of CO_2.

The international community has attempted to gain control over, and create stability within, global energy markets. Indeed, one of the reasons for establishing the International Energy Agency (IEA) in 1974 after the first oil crisis, was precisely this need to increase global energy security. At the time of its establishment the main focus was oil but today, global economic growth and particularly the economic growth rates of developing countries such as China and India have increased the world's demand for different energy sources. Energy security can therefore be regarded as an important global challenge. Some analysts of energy policy have interpreted the ongoing need to ensure the energy supply for national economic growth from the geopolitical perspective, suggesting that there is global competition over energy resources. Other analysts however emphasize more coordinated international efforts in order to ensure the effective operation of international energy markets. This latter approach can be seen in the renewal of the vocabulary of international affairs. Nowadays, 'energy diplomacy', 'energy dialogue', 'energy partnership' and 'energy cooperation' are commonly used terms in energy policy debates. Taking into account the high priority status of energy security in political agendas one can understand how nuclear power is perceived as a tempting option for individual nation states when planning their energy strategies. Still, the history of nuclear power illustrates how the artfulness of societal and technological development may continue to have profound effects on the societal status of nuclear energy.

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