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Waiting for the Nuclear Renaissance: Exploring the Nexus of Expansion and Disposal in Europe

Robert Darst, ***University of Massachusetts-Dartmouth***
Jane I. Dawson, ***Connecticut College***

Abstract

This article focuses on the growing prospects for a nuclear power renaissance in Europe. While accepting the conventional wisdom that the incipient renaissance is being driven by climate change and energy security concerns, we argue that it would not be possible without the pioneering work of Sweden and Finland in providing a technological and sociopolitical solution to the industry's longstanding "Achilles' heel": the safe, permanent, and locally acceptable disposal of high-level radioactive waste. In this article, we track the long decline and sudden resurgence of nuclear power in Europe, examining the correlation between the fortunes of the industry and the emergence of the Swedish model for addressing the nuclear waste problem. Through an in-depth exploration of the evolution of the siting model initiated in Sweden and adopted and successfully implemented in Finland, we emphasize the importance of transparency, trust, volunteerism, and "nuclear oases": locations already host to substantial nuclear facilities. Climate change and concerns about energy independence and security have all opened the door for a revival of nuclear power in Europe and elsewhere, but we argue that without the solution to the nuclear waste quandary pioneered by Sweden and Finland, the industry would still be waiting for the nuclear renaissance.

Keywords: high-level radioactive waste, permanent nuclear waste disposal, nuclear power in Europe, nuclear politics in Finland and Sweden

Author Notes: Robert Darst is Associate Professor of Political Science at the University of Massachusetts-Dartmouth, and Jane Dawson is Weinmann Professor of Environmental Studies and Government at Connecticut College; Professors Dawson and Darst take equal responsibility for this article as joint first authors.

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Introduction

After decades in the doldrums, the nuclear power industry is now on the cusp of a renaissance. Since 2002, when Finland's parliament approved the construction of a new nuclear reactor—the first new construction start in Western Europe, outside of France, since 1988, and only the second since 1980—plans for new nuclear builds have emerged across the length and breadth of Europe and beyond (Falksohn 2007; *Economist* 2007). As of 2010, barring some unforeseen nuclear disaster, the industry appears to be headed for a full-scale revival in Europe and across the Atlantic, sweeping the United States and Canada as well. Growing recognition of the threat of climate change and acceptance of nuclear power as a low-carbon energy option are widely credited with this rebirth of what seemed only a decade ago to be a dying industry (Venables 2006). While these factors have been undeniably crucial, we argue that this general wisdom overlooks a very important factor. The "nuclear renaissance," if it succeeds, will have been made possible by Sweden and Finland's pioneering work in eliminating the industry's Achilles' heel: the permanent, safe, and locally acceptable disposal of the high-level radioactive waste (HLW) generated by the production of nuclear energy.[1] Were it not for the growing perception that this problem now has a solution, the prospects for a climate change–driven nuclear renaissance would be significantly reduced.

In our previous work, we have argued that the future of nuclear power is tightly linked to the resolution of what has long been viewed as the industry's central failing: its inability to provide an acceptable solution to the problem of the highly radioactive waste generated by nuclear energy production, waste that remains a danger to humankind for tens of thousands of years and thus defies simple solutions for disposal (Darst and Dawson 2008; Dawson and Darst 2006). While science and engineering have moved forward in developing long-term disposal technologies that are widely viewed as safe within expert communities (International Atomic Energy Agency [IAEA] 2003), implementation of these technologies has lagged, as public perceptions of the risk of hosting a nuclear waste "dump" in one's own backyard have remained high. In country after country across the industrialized world, local communities have risen up to vociferously protest any attempts to site radioactive waste disposal facilities in their neighborhoods, impeding all efforts to successfully address this vital problem and preventing the turnaround in public opinion toward the nuclear

[1] The view of nuclear waste as the "Achilles' heel" of the nuclear power industry is widely accepted; see, for example, Blowers et al. (1991, 1).

option so hoped for by the backers of nuclear power. Antinuclear activists, in turn, have pointed to the absence of a socially acceptable waste disposal solution as evidence that nuclear power is dangerous and unsustainable, and have demanded that existing nuclear plants be phased out before any final decision is made about the disposal of the waste already generated.

The shadow cast over the future of the nuclear power sector by the unresolved and seemingly insoluble problem of the permanent disposal of its spent nuclear fuel (SNF) now appears to be lifting due to two significant developments, both initially pioneered in Sweden. The first is the development of a storage technology, KBS-3, which greatly reduces the geological requirements for the siting and construction of a deep underground repository for the permanent disposal of HLW, and thus increases the number of feasible candidate sites in most countries.[2] This technological innovation was coupled with a second shift: the adoption of a political process based on local volunteerism rather than imposition by the central government. In the wake of these two developments, the dynamics of the repository siting process have changed dramatically, and prospects for "solving" the nuclear waste problem appear greatly improved.

The full implications of these innovations for the revival of nuclear power production were not immediately apparent, however, because the Swedish waste siting exercise took place within the context of a national moratorium on new nuclear construction and an official pledge to phase out the use of nuclear power in Sweden. Since this was precisely the combination sought by antinuclear activists across Europe, it still remained to be seen whether a successful siting exercise could instead be combined with a renewed commitment to the use of nuclear power. That question was answered in the affirmative by neighboring Finland, which successfully adapted the Swedish siting approach in the late 1990s (Elam and Sundqvist 2009a, 14). Although the Finnish siting exercise was not explicitly tied to new nuclear construction, the successful selection of a repository site was followed almost immediately by the approval of the construction of an entirely new nuclear reactor, despite fierce opposition from antinuclear Greens within the governing coalition (IAEA 2002, 1).

The third step in the evolution of this new approach—to explicitly link, in advance, the resolution of the nuclear waste problem with new nuclear construction—was taken by the United Kingdom. When the British government announced in 2006 that it would copy the strategy of Sweden

[2] The KBS-3 technology emerged out of the nuclear industry-led KBS (karnbranslesakerhet, or nuclear fuel safety) Programme. For more details, see Elam and Sundqvist (2009b).

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and Finland,[3] asking local communities to volunteer to be considered to host a deep geologic repository, the media in Britain responded with incredulity, with headlines like "Nuclear waste: you know you want it" (Linklater 2006) and this satire in *The Guardian*:

> Wanted: Communities to volunteer to host a giant underground nuclear bunker. Guaranteed jobs for thousands of years; attractive annual payment package; should be in geologically stable area.
> Need to know: 10bn plus construction package will involve excavation of hundreds of millions of tons of rock, and the building of new roads, railway lines and workshops. Site may attract terrorists; potential safety risk for one million years or more (June 26, 2007).

And yet, by 2007, communities in west Cumbria were already volunteering, thus demonstrating that the voluntary approach may serve as a model far beyond its Nordic roots.[4]

West Cumbria's willingness to be considered for both a radioactive waste repository and new reactor construction illuminates the secret to success: it is not simply any community, but a *nuclear community*. In the Swedish, Finnish, and British cases, communities already home to nuclear power facilities have read the message: solve the nuclear waste problem for the country and your nuclear power station will stay open or even expand. In Sweden, where two nuclear communities vied for the privilege of hosting the nuclear waste repository,[5] the solution to the problem correlates strongly with the government's retreat from the country's planned phaseout of nuclear power; in Finland, the successful siting led immediately to the approval of new nuclear construction in the country; and in the UK, the government took the obvious next step of explicitly linking the solution to the nuclear waste problem to the future expansion of the nuclear sector in Britain.[6] As a result of this linkage, communities dependent on nuclear

[3] Announced in Tony Blair's "Energy Review," July 2006. For details and discussion, see *Platts EU Energy* (2006); Webb (2007).
[4] Communities willing to consider siting a repository in west Cumbria include: Allerdale Borough, Copeland Borough, and Cumbria County. For an example of the activities of the West Cumbria Managing Radioactive Waste Safely Partnership (MRWS), see 3KQ (2009).
[5] The two communities were Oskarshamn and Forsmark; see Dawson and Darst (2006).
[6] United Kingdom Government News (2005); United Kingdom Department of Energy (2006); United Kingdom Department of Trade and Industry (2007).

power production for jobs and income have been more than willing to volunteer themselves to be the savior of the industry.

In this paper, we will track the long decline and sudden resurgence of nuclear power in Europe, examining the correlation between the fortunes of this industry and the emergence of the Swedish model for addressing the nuclear waste problem. We will then turn to the Finnish case, and examine in detail how different political actors and constituencies interpreted the lessons and possibilities of employing the Swedish model—both technologically and politically—and how the outcome reflected or defied their expectations. We conclude with a brief overview of how quickly the lessons of Sweden, Finland, and, most recently, the United Kingdom appear to be gaining hold across Europe and implications for the nuclear renaissance that we expect around the corner. Climate change, recurrent Russian manipulation of gas supplies, and concerns about energy independence and security have all opened the door for a revival of nuclear power in Europe and elsewhere; but we argue that without the solution to the nuclear waste quandary pioneered by Sweden and Finland, the industry would still be waiting for the nuclear renaissance.

Siting in Limbo: Nuclear Power and Radioactive Waste Disposal in the European Union in the 1980s and 1990s

By the early 1990s, the fortunes of the Western European nuclear power industry had fallen to a very low ebb. The eventual phaseout of nuclear power throughout most of Western Europe seemed virtually inevitable, in part due to widespread public concerns about operational safety, and in part due to the utter failure of national efforts to identify politically acceptable solutions to the problem of long-term HLW disposal. Even in France, which continued to build new reactors throughout the 1980s, the French nuclear industry made no progress on the waste disposal front, thus failing to generate a model that might have restored the broader European public's confidence in the long-term viability of nuclear power.[7] Elsewhere in the European Union, antinuclear activists successfully halted new construction and pressed for the accelerated decommissioning of existing units.[8]

[7] France passed a nuclear waste strategy bill establishing a national program for the management of high-level nuclear waste (and research and development leading to construction of a deep geologic repository) in 2006, and has confronted strong local opposition in its site selection process (Kestenbaum 2007).

[8] For more on the rise of antinuclear activism in Europe and beyond, see Rüdig (1990).

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Antinuclear activists also resisted all efforts to move the continent's growing stockpile of radioactive waste from temporary to permanent storage, arguing that any permanent solution must not only be safe and socially just, but must also be linked to the irreversible phaseout of the industry that had produced that waste in the first place.

The nuclear industry's near-death experience was the product of a long decline that began in the mid-1970s. The initial development of commercial nuclear power in the 1950s and early 1960s proceeded with relatively little controversy: the reactors were small (typically less than 500 MWe) and few in number outside of the UK. In the late 1960s and early 1970s, several European states began to build larger reactors in larger numbers, or considered doing so. In contrast to the earlier period, these plans for expansion—which coincided with the birth of the environmentalist movement—generated widespread public opposition.[9] Even before the 1979 Three Mile Island accident in the United States, the construction of new nuclear power plants began to drop in the face of increasingly large public protests, legal challenges, protracted delays, and rising costs associated with more demanding licensing procedures and safety standards. Austria abandoned nuclear energy altogether in 1978 after a national referendum, in the process halting work on a plant almost ready for operation (Patterson 1979).

After the Three Mile Island accident, reactor orders plummeted still more precipitously. Several states that had originally planned the construction of nuclear plants—including Denmark, Greece, Ireland, Luxembourg, Norway, and Portugal—decided to forego nuclear power altogether, while others decided to scale back their nuclear programs. In 1980, the Swedish parliament voted (again in the wake of a national referendum) to allow the completion of six reactors already under construction, but also to phase out the use of nuclear power by 2010 (Löfstedt 2001). A still more striking turnaround took place in Spain, where in 1984 the government imposed a moratorium on five reactors under construction at three new plants. Two of these plants, each consisting of two reactors, were estimated to be 50 percent and 92 percent complete at the time (IAEA 2001, 226, 258). Elsewhere, construction began in 1980 on a dozen reactors that had been approved before TMI, but this was the last banner year for new construction starts in Western Europe. Even in France, which successfully shielded its nuclear power program from public opposition, new

[9] See, for example, Nelkin and Pollak (1977; 1981); Falk (1982); Kitschelt (1986); Rüdig (1990); Jasper (1990); Flam (1994).

reactor starts dropped sharply in the second half of the 1980s as the domestic market became saturated.[10]

By 1986, the expansion of nuclear power in Western Europe had slowed to a crawl. At this point, however, the success of the antinuclear movement was limited primarily to a sharp reduction in new construction starts. The vast majority of the reactors already under construction were to be completed, and those online would remain in operation for the duration of their planned lifespan. The Austrian and Spanish decisions to halt the construction of nearly finished reactors were anomalies, as was the Swedish phaseout plan, which envisaged a generous time frame and was hedged with loopholes that would permit postponement if economic conditions were not conducive to a phaseout in 2010. In April 1986, however, this shaky equilibrium—which was to the liking of neither the nuclear industry nor antinuclear activists—was upset by the catastrophic accident at the Chernobyl nuclear power plant in the USSR. While the design of the Chernobyl plant was very different from those used in Western Europe, the accident was far more serious than Three Mile Island, exposing tens of millions of Western Europeans to elevated levels of radiation. Moreover, as communism subsequently crumbled in Eastern Europe and the USSR, Western European confidence in nuclear power was further undermined by a growing deluge of information about the dangerously low level of nuclear safety throughout the former Soviet bloc (Darst 2001, 149-166).

In the wake of the Chernobyl accident, new reactor starts stopped altogether, most reactors planned or under construction were canceled, and several others were closed ahead of schedule. In Italy, a series of referenda in 1987 led to the immediate halt of all nuclear power production and construction (IAEA 2009c). In Sweden, the parliament decided in 1988 to begin the phaseout of nuclear power in 1995, earlier than originally planned (IAEA 2009d). In Belgium, the government decided in 1988 to indefinitely postpone the construction of an additional reactor (IAEA 2009a). In 1989, the Swiss parliament voted to halt the construction of a controversial new reactor; the following year, Swiss voters approved a 10-year moratorium on additional nuclear construction (IAEA 2009e). The UK initially appeared to buck this trend, approving the construction of a new reactor in 1987, but this proved a Pyrrhic victory: in 1989, well before the new reactor came online, the government shelved its plans to allow private nuclear power production and announced an indefinite moratorium on the public construction of any

[10] For detailed historical data on reactor construction and operation in all of these countries, see the International Atomic Energy Agency's online Power Reactor Information System (http://www.iaea.org/programmes/a2/index.html).

additional reactors (IAEA 2009f). Even in France, new reactor construction starts slowed to a stop in the early 1990s—although this was due more to saturation of the domestic market than to antinuclear protest (Grubler 2009, 11-13). Thus, by the early 1990s, antinuclear activists throughout most of the European Union were able to shift from blocking new construction to demanding the accelerated phaseout of existing units.

This low ebb in the industry's fortunes was exacerbated by its failure to advance a politically acceptable solution to the problem of long-term radioactive waste disposal. As commercial nuclear power entered its sixth decade in the mid-1990s, no country anywhere in the world, including Western Europe, had opened a repository for the final disposal of SNF and HLWs, or cleared the political and legal obstacles to doing so. Where European governments attempted to announce the selection of a repository site "from above," the resulting explosion of local and national opposition prompted either a quick retreat or, as in Germany, a protracted conflict that further galvanized the antinuclear movement (Fischer and Boehnke 2004).[11] More often, European governments simply avoided precipitous action, kicking the problem down the road for another government on another day.

By the 1990s, many on both sides of the nuclear debate had identified radioactive waste disposal as the nuclear industry's "Achilles' heel." Antinuclear activists argued that no safe and socially just solution to the waste problem could be found in the foreseeable future, if ever, and so demanded that nuclear power—and thus the generation of additional waste—be phased out as quickly as possible. On the other hand, many proponents of the nuclear industry, such as the officials responsible for nuclear power within the European Commission, argued for more rapid action to develop acceptable solutions to the radioactive waste problem. Only then could the antinuclear argument be disproved, and the way opened for a new round of reactor construction (Darst and Dawson 2008).

This joint identification of radioactive waste disposal as the nuclear industry's "Achilles' heel" did not, however, translate into joint interest in

[11] Italy provides an instructive example of the "quick retreat" reaction. In November 2003, the Italian government issued an emergency decree on radioactive waste storage, in which it named the small town of Scanzano Jonico as Italy's final radioactive waste repository. All of the country's radioactive waste, including all of the spent fuel from Italy's four shut-down nuclear power reactors, was to be moved to Scanzano Jonico "immediately," where it would be kept in interim surface storage until the proposed underground storage facility was ready to receive it. Following two weeks of protests, however, the government removed the name of the town from the decree and established a scientific panel to investigate all possible sites. See *Nucleonics Week* (2003; 2004); *Nuclear Engineering International* (2004).

the prompt resolution of the problem. In advance of any evidence to support the argument that prompt repository siting would promote new nuclear construction, most pronuclear politicians and executives remained skeptical of the benefits of rapid movement on the waste disposal front. All experience thus far indicated that any site selection process would be tumultuous and controversial, at least in the short run, perhaps dealing the industry a mortal blow before it could reap the promised long-term benefits. On the other side, the industry's opponents were well aware that the unresolved waste problem was a tremendous asset in the campaign to phase out nuclear power, and did not wish to lose this asset prematurely. The opponents of nuclear power would therefore support a permanent solution to the radioactive waste disposal problem *only* if doing so would *also* advance the permanent phaseout of nuclear power—precisely the conditions under which the proponents of nuclear power would be *least* likely to support such action.

Given these opposed interests, we might have expected the radioactive waste disposal problem to have remained indefinitely unsolved, at least in any country with a meaningful antinuclear movement. Yet action, when it came, came not in France but in Sweden, where the antinuclear movement had been strong enough to bring about a moratorium on the construction of new nuclear power plants, and in Finland, at a time when the antinuclear Green Party was a member of the governing coalition. How can we explain this outcome?

The first cause lay in the nature of the process: persuasion and voluntary acceptance by the host community, rather than top-down imposition. This process, as it unfolded in both Sweden and Finland, prevented the emergence of effective coalitions between "national" activists opposed to nuclear power in general and "local" activists alarmed by the prospect of an unwanted radioactive waste repository in their immediate vicinity. In the United States and Germany, the proposed repositories at Yucca Mountain and Gorleben—both the products of top down, imposed siting processes—united local and national activists and became key battlegrounds over the future of nuclear power. In Sweden and Finland, by contrast, the decisions by Oskarshamn, Östhammar, and Eurojoki to volunteer as host sites nipped the emergence of such a coalition in the bud. On the one hand, the volunteer communities were "nuclear oases" in which antinuclear sentiment was muted, thus depriving national antinuclear activists of strong local partners. On the other hand, concerned local citizens in *other* candidate communities—especially the "virgin sites," where there was no prior nuclear presence—*did* make common cause with national

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antinuclear activists, but these coalitions were ephemeral, dissolving once the "virgin" communities were removed from consideration.

Second, when the siting process got underway in Sweden and Finland in the mid-1990s, most antinuclear activists did not believe that rapid action on the waste issue would lead to a reinvigoration of the nuclear industry. In Sweden, a moratorium was already in place, new construction was prohibited by law, and the government seemed intent to proceed with the first step of the phaseout, the closure of the Barsebäck nuclear power plant, despite strong opposition from the nuclear industry (Löfstedt 2001). In Finland, the stakes were much higher. Unlike their counterparts in Sweden, Finnish utilities were vigorously pressing for *new* nuclear construction. At the same time, unlike Sweden or any other country in Western Europe, Finland exported much of its HLW to another country, Russia, for permanent disposal. Most members of the antinuclear movement therefore assumed that a campaign to force Finland to dispose of its HLW internally would undermine the utilities' campaign to expand the country's reliance on nuclear power. In the end, this calculation proved mistaken, but by then it was too late to reverse the process.

Breaking the Roadblock: Sweden Changes the Rules

When the Swedish government launched the process in 1977 that led to the development of the versatile KBS-3 concept and the innovative siting strategy that followed (Elam and Sundqvist 2009b), the last thing on anyone's mind was pioneering a process that might lead to the survival and resurgence of the nuclear power industry. In fact, antinuclear sentiment in Sweden was exceptionally high and the country had been engaged in a serious national debate over the future of nuclear power in Sweden since the early 1970s (Löfstedt 2001). The process was launched by a vehemently antinuclear prime minister and sped along by referenda and government actions which allowed the nuclear waste issue to be addressed in the seemingly safe setting of a country that had firmly rejected the expansion of the industry. Thus, it is ironic that the outcome of the process was a technology and strategy that are now being touted as a model for overcoming public resistance to new nuclear power reactor construction.

Indeed, the origins of contemporary Swedish radioactive waste policy can be traced back to the rise of the antinuclear movement.[12] In 1976,

[12] This section draws on excellent overviews of the development of Swedish radioactive waste policy, the KBS Programme, and the KBS-3 concept, including Lidskog (1994);

in response to the growing national debate over the future of nuclear power, an official committee to study the issues of SNF and radioactive waste was formed. It quickly handed over authority for addressing the issue to the nuclear industry's Swedish Nuclear Fuel Supply Company (SKBF), which was then tasked with addressing the issue of waste disposal promptly by parliament's 1977 Stipulation Act, which required that the nuclear industry come up with an "absolutely safe" solution to the nuclear waste problem before nuclear fuel could be delivered to new reactors then under construction. While the nuclear industry certainly had an interest in overcoming the nuclear waste problem and thus ensuring the survival of the industry itself, the opponents of nuclear power were also enthusiastic about the Stipulation Act, as they assumed it would reveal for all to see the severity and intractability of the nuclear waste problem, thus assisting in their goal of curtailing and eventually closing down the industry.

With the threat of the Stipulation Act hanging over them, the SKBF launched what has since become known as the KBS program on nuclear fuel safety and began earnestly exploring options for safely disposing of the waste. While their initial inclination was toward reprocessing (the KBS-1 concept), changes in attitudes and logistical possibilities for reprocessing gradually led the program to shift its focus toward deep geologic disposal and to concentrate its efforts in this direction. With this shift from reprocessing to permanent waste disposal, SKBF reoriented its mission and became the SKB, the Swedish Nuclear Fuel and Waste Management Company, which has continued to oversee all nuclear waste issues in Sweden to this day. In 1984, the KBS-3 concept for deep geologic disposal was announced and the serious work of fully developing the technology for actual implementation and working through a strategy for siting such a facility began.

In moving forward to address nuclear power's central failing, antinuclear activists, citizens, and politicians felt they had little to fear. First, a national referendum held on the question of nuclear power in 1980 had called for a phaseout of the industry, based on 25-year maximum reactor lifetimes and the closure of the last reactor by 2010. Perhaps even more important was the passage of the 1984 Act on Nuclear Activities, which explicitly forbid the construction or operation of any new nuclear reactors in Sweden, thus closing the door completely to any possible hopes for the expansion of the industry. Within this context, the SKB was able to develop

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Sundqvist (2002); Lidskog and Sundqvist (2004); Sjöberg (2004); Elam and Sundqvist (2009a; 2009b).

its technology and siting strategy without being overwhelmed by antinuclear opposition.

Most discussions of the Swedish siting process focus on the 1995–2002 period, when SKB announced six municipalities as potential host sites, began serious on-site investigations, and finally narrowed the finalists to three, and then two. Yet the process began long before 1995. SKB's ultimately successful approach—one based on volunteerism, local rights, and partnership—emerged from a largely untold story of conflict and failure in the 1980s, a learning experience that SKB took to heart in its second round of siting in the 1990s. Throughout the 1980s, SKB engaged in geologic investigations with the assistance of the Swedish Geologic Authority, looking for the "best" bedrock site in which to locate the facility. While none of the areas being investigated were officially designated as candidate sites, it was obvious to the local communities that they were under consideration. As SKB officials now acknowledge, local protests were widespread and entirely derailed the investigation process.[13]

As the technology and understanding of geologic conditions evolved in the 1980s, however, SKB came to the conclusion that a "best site" strategy was not necessary; rather, many sites would be perfectly "adequate" from a technical point of view, and so political considerations moved to the forefront (SKB 1992; Berkhout 1991, 127). This shift—both technologically and strategically—led to a much more successful second round of siting. As an SKB official put it, "location is about much more than geology."[14] In 1992, SKB launched the second round with a media campaign, announcing its intentions and asking municipalities across the country to contact SKB if they wanted to be considered—no strings attached (Lidskog 1994, 67). This was followed by feasibility studies in numerous promising sites. In addition, SKB recognized the pronuclear orientation of municipalities already home to the nuclear power industry, and invited four such municipalities to join in the process. All four accepted, but only two proved to have adequate geologic conditions, leaving two nuclear oasis sites in the running. In 2002, SKB announced its three finalists: Oskarshamn, Forsmark/Östhammar, and Tierp. And, as if to demonstrate that its promise to not proceed without local acceptance was genuine, when Tierp—the only "virgin site" among the three—voted to withdraw from consideration, SKB accepted its withdrawal and continued to work with the two remaining sites (Johansson 2003). Thus, after all of the investigation and years of geologic work, in the end only the

[13] Discussion of this first (unsuccessful) round of siting is drawn largely from author interviews with key figures at SKB (Stockholm, 2006) and supported in Lidskog (1994).
[14] Author interview, SKB, Stockholm, 2006.

nuclear oases remained in the game—a lesson that others now adopting this model of volunteerism and partnership have not missed.

As the siting process moved forward and public interest in the nuclear power issue simmered down, the government's commitment to the nuclear phaseout also began to show signs of wavering. As phaseout dates loomed closer, the government became keenly aware of the economic costs of shutting down the power stations that provided the country with over 40 percent of its electricity and the overwhelming challenge of replacing that energy production by the time all stations were slated to be closed in 2010. In 1997, the government formally retreated from the schedule laid out in 1980, allowing the lifetimes of reactors to be extended from their 25-year limit under the 1980 plan to up to 60 years, and thus removing the 2010 target date for total phaseout. The commitment to an eventual phaseout and no new builds was maintained, but nuclear power seemed to slowly be making its way back toward acceptability within the government's energy strategy (Löfstedt 2001).

The 1995–2002 formal siting process itself benefited from the initiatives taken by local municipalities to ensure that the process was a genuinely democratic process based on partnership and volunteerism.[15] One municipality in particular, Oskarshamn, stepped forward to take the lead in pushing for a process based on transparency, equality, and trust that has developed to such a level that it is now known as the "Oskarshamn model" and has been heralded as the template for successful siting well beyond the Swedish context (Carlsson et al. 2001; Thomson 2004). Led by an activist mayor who was quick to recognize the benefits to his municipality and the industry that kept it alive, the Oskarshamn committee put forward demands for information, partnership, and bargaining opportunities that pushed SKB to further enunciate its own commitment to municipality rights. While SKB officials acknowledged that nothing in the letter of the law requires a voluntary siting process and the rights of veto, SKB as the private entity overseeing the process guaranteed that municipality vetoes would be unconditionally respected (Swedish Radiation Protection Authority 2002; Sjöberg 2004, 738). Thus, the siting strategy that is now being emulated elsewhere was not thought out in advance, but rather evolved through a learning process and the SKB's pragmatic willingness to respond to local demands and incrementally open the process ever further. With the final siting decision announced in the summer of 2009—one which favored Östhammar/Forsmark and left the Oskarshamn municipal leaders greatly

[15] For more information on SKB's communication strategy and work with the public, see Soneryd and Johansson (2010).

disappointed (Saines 2009)—the rather daring decision of SKB to put its trust in an open process based on volunteerism and respect for veto rights finally yielded its long sought outcome.[16]

The Swedish case not only laid the groundwork for other countries to resolve their nuclear waste disposal problem, but also reinforced the belief that resolution of the nuclear waste issue and continuation of nuclear power production are inextricably linked. While the 1997 decision to discard the rapid phaseout schedule established in 1980 marked an important turning point for the industry, a still more fundamental shift occurred in 2009–2010. On February 5, 2009, in a major shift for the Center Party of Sweden, the coalition government announced its intention to scrap the results of the 1980 referendum supporting nuclear phaseout and the 1984 act forbidding new nuclear construction in Sweden. Citing the need to expand energy production while reducing carbon emissions, the government announced its intention to permit the replacement of existing nuclear reactors with more advanced models (Macalister 2009; Kanter 2009). Parliament narrowly passed the necessary legislation in June 2010 (Ward 2010). While the new bill does not allow for new construction beyond replacement of existing reactors, the trajectory from 1980 is likely to serve as incontrovertible evidence of the rewards that the nuclear industry might reap through successful resolution of the longstanding nuclear waste quandary.

While the full implications of the Swedish case are still emerging, the technological and strategic siting lessons were recognized by a few astute observers as early as the 1980s and 1990s. Adopting the KBS-3 concept, a volunteerist strategy, and a growing recognition of the importance of nuclear oasis sites in the grand scheme of permanent nuclear waste disposal, Finland was the first to take the Swedish lessons to heart and test the full implications for the future of the nuclear power industry itself. Thus we turn now to the Finnish case and how the lessons of its neighbor were perceived by politicians, antinuclear activists, and the nuclear power industry as they debated how to move forward in addressing their nuclear waste disposal problem.

[16] For public opinion information on the two sites, see Sjöberg (2003).

Testing the Implications of the Swedish Model: The Finnish Experience

In May 2001, Finland became the first country in the world to successfully clear the major political and legal obstacles to the construction of a domestic HLW repository.[17] This outcome is very interesting—even surprising—for several reasons. First, the Finnish government and nuclear industry originally planned to avoid a domestic HLW repository by exporting all HLW abroad. In fact, Finland was the only country in Western Europe to actually do so: until the mid-1990s, all SNF from one of Finland's two nuclear power plants was shipped to Russia for final disposal. Second, the impetus for the ban on waste exports that ultimately brought these shipments to an end was provided by the antinuclear Green League, despite the fact that none of the party's constituents were keen to have a repository sited in their own districts. Third, the Finnish nuclear industry, which at first opposed the export ban, subsequently succeeded in identifying a willing host community in very short order, overcoming the obstacles that have frustrated HLW repository siting virtually everywhere else. Finally, the Green League was part of the government that approved the siting of a national repository in the municipality of Eurojoki in 2001, even though this decision was widely expected to pave the way for approval of a fifth reactor.

This puzzling outcome came to pass because a strategy designed to make the disposal of Finland's radioactive waste *more* difficult—a ban on the import and export of radioactive waste from Finland—instead had the contrary effect of making it easier. The proponents of the import/export ban hoped not only to end Finland's contribution to radioactive contamination in Russia (the primary public rationale for the ban), but also to head off the further development of nuclear power by forcing the country to internalize the full political and economic costs of HLW disposal. This effort failed because the nuclear industry convinced the communities surrounding the existing nuclear reactors that prompt HLW disposal and nuclear power generation were indeed inextricably linked, and that only acceptance of the former could ensure the future of the latter. Once the nuclear industry succeeded in making this case, the Greens found themselves outmaneuvered. The Green League was able to make common cause with local anti-

[17] The occasion was parliamentary approval to begin preliminary construction on the basis of the agreement reached between the nuclear power industry and the host municipality of Eurojoki. The site would still need to be approved by the national nuclear regulatory agency, STUK, before it could go into actual operation (*Nucleonics Week* 2001).

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repository protesters in the "virgin" sites under consideration, but not in the nuclear oases. At the national level, the Greens lacked the votes to successfully oppose the Eurojoki agreement, and feared that any effort to do so would not only appear hypocritical, but would also be unpopular among newly energized party activists in the "virgin sites," for whom the decision to site the repository in Eurojoki was not a defeat, but a success. Finally, once the waste issue was perceived as having been solved, the pendulum of elite and public opinion swung in favor of the fifth reactor—just as the pronuclear proponents of domestic waste disposal had anticipated.

Finland launched its nuclear power program during the Cold War, and its choices reflected the uneasy position that the country then occupied between East and West. In 1969, the state-owned utility IVO negotiated the purchase of a pair of nuclear reactors from the USSR. Having thus propitiated its neighbor to the east, the Finnish government authorized the privately owned utility TVO to purchase a second pair of reactors from Sweden, Finland's closest neighbor to the west. The reactors purchased from the USSR were constructed near the town of Loviisa on Finland's southern coast, while those purchased from Sweden were built on the island of Olkiluoto, in the municipality of Eurojoki on the western coast. All four reactors went online between 1977 and 1980. Initially, neither utility made any serious provision for permanent HLW disposal within Finland, as both expected to be able to permanently dispose of the reactors' SNF abroad. For IVO, this arrangement was part of the purchase package: the USSR agreed to supply the Loviisa plant with fresh fuel and to accept all spent fuel in return—not simply for reprocessing, but for the final disposal of all residual waste as well. Western suppliers did not offer analogous arrangements for commercial reactor purchases, but TVO anticipated in the early 1970s that SNF would be sufficiently valuable to the reprocessing industry, and Finland's supply sufficiently small, that it would be able to export Olkiluoto's spent fuel for reprocessing abroad without receiving residual waste in return (Kojo 2006, 6-12; Darst 2001, 146-148; IAEA 2009b).

By the time TVO began negotiating with potential reprocessors in the late 1970s, however, reprocessing was no longer as lucrative as had seemed likely earlier in the decade. TVO was unable to conclude an agreement, even with residual waste returned, at a price that it was willing to pay, and in 1979 rejected the tenders submitted by potential reprocessors. At this point, the Ministry of Trade and Industry, which oversaw the nuclear power industry, impressed upon TVO the need to pursue a two-track strategy: in the event that the export of HLW proved infeasible, TVO should begin planning for the construction of a permanent repository within Finland. In 1983—with the prospect of full disposal abroad still more

remote—the government issued a "decision in principle" establishing a timetable for the siting and construction of a domestic HLW repository. Preliminary screening of possible sites would begin immediately, preliminary site investigations in 1986, and detailed site investigations in 1993. Final site selection would take place in 2000, and actual operation in 2020. (Given the 40-year aboveground cooling period required before SNF could be placed permanently in an underground repository, this was as ambitious a timetable as could be imagined.) After one last try in 1987–1988 to negotiate an agreement with the USSR similar to IVO's, TVO finally abandoned the option of waste export. This was due not to domestic criticism of waste exports, but instead to TVO's failure to find an importing country that would keep all of TVO's waste at a cost comparable to that of constructing a domestic repository. Meanwhile, IVO continued to export the Loviisa plant's waste to the USSR, just as it had always done.[18]

In most countries, the task of repository siting is the responsibility of the central government. In Finland, this task—including the most difficult task of securing local acceptance—was delegated to TVO. Like their counterparts in Sweden, the TVO officials involved initially defined the problem in technical terms: potential sites were selected on the basis of their geological characteristics, with the final choice to be made after extensive on-site investigations, and little consideration was given to public reaction. Consequently—just as in Sweden—TVO's initial efforts to identify a site met with failure. In January 1984, TVO announced that it would carry out test drillings of the bedrock in the municipality of Lavia (a "virgin" site with no preexisting nuclear industry), without first consulting either the local political leadership or the public at large. The local reaction was predictably negative: by the end of the month, the local council voted to oppose cooperation with TVO. Two years later, in March 1986, TVO tried the same strategy again in the municipality of Ikaalinen (another "virgin" site), and again quickly abandoned its plans for site testing in the face of local protest (Kojo 2005, 4; 2006, 66-67).

Since TVO did not have governmental powers, it could not impose a site investigation upon an unwilling community. This limitation, coupled with the lessons learned by SKB in neighboring Sweden, led to a radically revised strategy of seeking local acceptance first, and only then proceeding with more detailed site investigations. After the failure at Ikaalinen, TVO solicited expressions of interest from local councils, and then embarked on

[18] This discussion of the evolution of Finnish radioactive waste disposal policy is based primarily upon author interviews with Eero Patrakka, President, and Timo Äikäs, Vice President for Engineering, Posiva Oy, Olkiluoto, August 2006; also see Kojo (2009).

extensive public relations campaigns in the municipalities that seemed most promising. At the end of 1992, TVO announced three "semifinalists": Eurojoki, Äänekoski, and Kuhmo (McEwen and Äikäs 2000, 9-11; Kojo 2005, 4-5). Initially, there was little enthusiasm for a repository in any of these municipalities. Äänekoski and Kuhmo were "virgin sites" with no previous exposure to the nuclear power industry, and so were predictably skittish. And although Eurojoki was home to TVO's Olkiluoto nuclear power plant, the municipal council had, in 1980, sought and received written assurance from TVO that final disposal of the plant's radioactive waste would not take place in the municipality (Kojo 2009). Loviisa, home to IVO's nuclear power plant, was not among the semifinalists at this stage, as the Loviisa plant's waste continued to be exported to Russia.

Despite the semifinalists' reluctance, the TVO team's new strategy of putting local acceptance first would ultimately pay off—but not before the broader political context of radioactive waste disposal in Finland underwent a dramatic transformation in the early 1990s. This transformation was brought about by three interrelated developments: the rise of the Green League as a major force in national politics; the passage in 2004 of a ban on the export and import of radioactive waste; and a political battle over the construction of a fifth nuclear reactor. These developments culminated in a ban on the import and export of radioactive waste to and from Finland, and the merging of the politics of radioactive waste disposal with those of the further expansion of nuclear power.

In the wake of the election of several independent candidates running on "green" platforms, the Green League was organized as a national political party in 1988. The Greens emerged from the 1991 parliamentary elections with enough seats (10 out of 200) to be an influential within the multiparty Finnish political system, and in 1995, following a second successful electoral campaign, the Green League joined the government—the first European Green Party to do so (Sundberg and Wihelmsson 2004; Rüdig 2002, 25). The rise of the Green League coincided with the disintegration and collapse of the USSR, a process that was accompanied by a dramatic outpouring of information about the extraordinarily poor condition of nuclear power safety and radioactive waste management throughout the former Soviet bloc. With support from antinuclear activists in Russia and the Norwegian NGO Bellona, the Green League succeeded in raising public awareness of the extraordinarily poor condition of nuclear safety and radioactive waste storage in Russia, and the dangers that this

posed to the Nordic countries.[19] In the process, the Greens and their allies succeeded in delegitimizing the export of SNF from the Loviisa nuclear power plant to "Mayak," the dysfunctional and highly contaminated Russian interim storage and reprocessing facility near the Siberian city of Chelyabinsk.[20]

The push for a ban on radioactive waste exports to Russia coincided with Finland's impending entry into the European Union, which some feared might lead to the *import* of other countries' waste *into* Finland. To deflect these concerns—which, if allowed to run unchecked, might undermine public support for European Union membership in advance of the October 1994 referendum on accession—the Nuclear Energy Act was amended in 1994 to ban both the export *and* import of radioactive waste, and Finland's accession to the European Union was made conditional upon the European Union's acceptance of Finland's ban on radioactive waste import.[21] Since TVO no longer considered the export of SNF from Olkiluoto to be a viable option, the major casualty of the export ban was IVO, whose export arrangement with Russia would permanently expire when the ban came into effect in 1996. As a result, IVO joined with TVO in 1995 to create a new joint radioactive waste management company, Posiva Oy, which carried on TVO's ongoing site selection campaign (McEwen and Äikäs 2000, 3-4).

Finally, the radioactive waste issue intersected with the nuclear industry's application in 1991 for permission to build a fifth nuclear reactor, to be operated jointly by TVO and IVO. The debate over the fifth reactor provided a powerful additional impetus for the campaign for a waste export ban, since its effect within Finland would be to raise the political and economic costs of continued reliance on nuclear power and thus, antinuclear activists calculated, make further expansion less likely. The reactor's opponents used the flood of information about the unsafe condition of nuclear power safety and radioactive waste management in Russia to bolster their arguments that nuclear power was inherently unsafe. Finland, they

[19] Bellona's efforts combined investigative journalism, the lobbying of politicians in the European and national parliaments, and public protests. The organization's findings were initially issued as press releases, and subsequently compiled in a series of extremely influential book-length reports. The first of these, *Sources of Radioactive Contamination in Murmansk and Arkhangel'sk Oblasts*, appeared in early 1994. That same year, Bellona and other activists blocked a train carrying radioactive waste from Loviisa to the Russian border. For a detailed timeline of the organization's activities, see Bellona (2010).

[20] Author interviews with former Green MPs Heidi Hautala and Pekka Haavisto, Green political advisor Tarja Parviainen, and former Green political advisor Taina Nikula, Helsinki, August 2006.

[21] OECD Nuclear Energy Agency (1995); European Union (1994).

argued, was unethically passing the costs of its nuclear power program on to the Russian people, who had no say in the matter; and Finland's need to export waste to Russia demonstrated that there was no safe solution to the problem of HLW disposal (Lammi 2009).[22] This argument carried the day: a divided cabinet approved the utilities' application in February 1993, but this decision was subsequently overturned by a parliamentary vote of 107-90 (Kojo 2006, 13).

Paradoxically, the early 1990s round of nuclear politics, which culminated in the import/export ban and the rejection of the fifth reactor, set in motion new dynamics that ultimately worked to the advantage of the nuclear industry and to the disadvantage of its opponents. First, the defeat of the proposal for the fifth reactor, after a heated debate in which waste disposal figured prominently, convinced a broad spectrum of people involved in the nuclear industry—including ordinary people living and working in the vicinity of the two plants—that the future of nuclear power depended upon a prompt solution to the waste issue. Second, TVO was no longer the only utility seeking a domestic waste disposal solution; IVO, which had previously devoted little planning to this option, now found itself scrambling to do so as well. After TVO and IVO joined forces, Loviisa (home to IVO's Soviet-designed reactors) was added as a fourth candidate site (Posiva Oy 1999). This had the effect of placing the two "nuclear oases" in competition with each other to host the repository and—more importantly—the future expansion of nuclear power generation.

In 1997–1999, Posiva launched an "environmental impact assessment" at the four sites, the main goal of which was to convince the public and local councils of the safety and economic benefits of hosting the repository.[23] While the public and the local councils were divided at all four of the candidate sites, there was a marked difference between attitudes at the "nuclear oases" on the one hand, and the "virgin sites" on the other. At all four sites, Posiva's persistent public relations efforts had a pronounced impact upon public opinion, but only in the nuclear oases did these efforts turn the tide. In Kuhmo, opposition to the repository declined from a high of over 70 percent in 1991 to just over 50 percent in 1999, while in Äänekoski public opposition surged to over 60 percent in 1996–1997 but then receded to just over 50 percent by 1999 (Kojo 2006, 70-75). This was a remarkable

[22] Also author interviews with former Green MPs Heidi Hautala and Pekka Haavisto, August 2006.

[23] See Posiva Oy (1999); Hokkanen (2001); Hokkanen et al. (2002); Leskinen and Turtiainen (2002); Kojo (2006, 24-53). This section also draws upon author interviews with Eero Patrakka, President, and Timo Äikäs, Vice President for Engineering, Posiva Oy, Olkiluoto, and Antti Leskinen, Diskurssi Oy, Helsinki, August 2006.

achievement, given increasingly well-organized local resistance at both sites, but in the end supporters of the repository remained in the minority, both in the local councils and among the citizens at large. In Eurojoki and Loviisa, by contrast, repository opponents dwindled into the minority. In both municipalities, public opinion was roughly evenly divided in 1992, but by 1999 support for the repository climbed to over 60 percent (Kojo 2006, 68-77).

This marked decrease in opposition at all four sites is testament to the quality and diligence of Posiva's effort to convince local residents of the safety of its technology, but this campaign alone did not ensure a successful outcome. Equally important were the anticipated financial benefits of hosting the repository itself and (once the waste disposal problem was addressed) further expansion of nuclear power production, in the form of new reactor construction.

The financial benefits of hosting the repository itself were expected to be enormous. In December 1994, the Eurojoki municipal council reversed its longstanding position (narrowly reaffirmed as recently as December 1993) that no permanent disposal of SNF could take place within the municipality. This reversal reflected the council's awareness that, with the passage of the import/export ban, the Olkiluoto plant's waste must be stored somewhere in Finland; and should the repository be built somewhere else, Eurojoki stood to lose over $2 million in annual tax revenues.[24] The subsequent addition of Loviisa as a rival site added to Eurojoki's determination to make the best possible deal with Posiva, lest the municipality be left with nothing—save perhaps the indefinite "interim" storage of Finland's SNF, should the site selection process fail entirely (Kojo 2009, 177-179). Consequently, Eurojoki actively engaged Posiva in negotiations over compensation, from near-term benefits like ice rinks and retirement homes to long-term tax revenues (Kojo 2009, 180-185). Once Loviisa entered the running, its municipal council likewise negotiated for immediate and long-term compensation, including funding for the Loviisa Energy Centre, a short-lived forum for Finnish-Russian nuclear safety cooperation.[25]

A far greater prize, in the eyes of both municipalities, was further expansion of nuclear power in Finland, and selection as the host site for new reactor construction. By the time negotiations with Posiva got underway, the Finnish nuclear industry was publicly committed to a revised proposal for a

[24] 11 million Finnish marks in 1999 dollars Posiva Oy (1999); Kojo (2009, 175-177).
[25] *NucNet* (2000); Kojo (2006, 62); author interviews with Eero Patrakka, President, and Timo Äikäs, Vice President for Engineering, Posiva Oy, Olkiluoto, August 2006.

fifth reactor after the next parliamentary elections in 1999.[26] In August 1999, TVO and IVO (now known as Fortum) submitted environmental impact analyses for new reactors at Olkiluoto and Loviisa, respectively (TVO 1999; Fortum Oy 2000). In 2000, the two proposals were then combined into a single application, filed by TVO, for one reactor which might be built at either location (*Helsingin Sanomat International Edition* 2000; 2001). Both municipalities expressed their willingness to host new reactor construction, and with little wonder, for the prospective benefits of hosting a new reactor were substantial: in 1998, the Eurojoki municipal council calculated that a new reactor would bring in $2.5–3.5 million in additional annual property taxes alone, considerably more than the repository (Kojo 2009, 179). Yet, at the national level, the proposed reactor remained controversial, not least because of the spotlight focused on radioactive waste by the import/export ban and the unresolved political challenges associated with domestic disposal (Lammi 2009, 74-75). Each municipality was therefore aware that failure to reach agreement with Posiva would make a fifth reactor less palatable to the parliament, while in the event of agreement, the successful municipality would be more likely to host the next new reactor (Kojo 2009, 179).

In the end, Eurojoki was the first to reach a final agreement with Posiva. In May 1999, even before the environmental impact assessment had run its course, the Eurojoki municipal council announced that it was willing to host the repository in exchange for a variety of financial incentives, on the condition that Eurojoki be named the only possible candidate for the repository. Before the month was out, Posiva presented the government with an application for a decision in principle (DiP) for the Eurojoki site. After a final round of negotiations with Posiva, the municipal council approved the DiP application in January 2000.[27]

In December 2000, the DiP came before the cabinet, one month after TVO submitted the new application for a fifth reactor. Antinuclear parliamentarians, including Green Minister of the Environment Satu Hassi, were aware that approval of the DiP would increase the chances for the approval of the fifth reactor, but found themselves with limited options. Having pushed for an import/export ban, the Greens could not suddenly reverse course, nor could they argue that the citizens of Eurojoki had been forced to accept the repository against their will. There was strong support for the waste DiP within both the cabinet and the parliament, so it appeared

[26] Author interview with Pekka Haavisto, Helsinki, August 2006.
[27] Author interviews with Eero Patrakka, President, and Timo Äikäs, Vice President for Engineering, Posiva Oy, Olkiluoto, August 2006; also see: Kojo (2009, 180-185).

certain to pass regardless of the position taken by Greens or other antinuclear MPs.[28] Furthermore, reopening the siting process at the national level would not sit well with those activists who had fought long and hard, with the support of the Greens and other national environmentalist groups, to keep the repository out of the *other* candidate sites. This was particularly true of Äänekoski, where four local opponents of the repository in Äänekoski successfully ran as Green League candidates in the 1996 municipal elections, thus extending the Greens' presence in central Finland—an area in which the party previously had little electoral success.[29]

The Greens' response was to present the waste issue as "unresolved" as possible, without directly opposing the Eurojoki agreement. First, the DiP reflected the Greens' long-running demand that the waste be "retrievable": that the repository be constructed so as to allow the future extraction of the spent fuel rods in the event that problems arose, or a better solution to permanent disposal became available (Lehtonen 2009). Beyond its practical merits, this insistence on "retrievability" was intended to underscore the continuing uncertainty and unknown risks associated with geological disposal. Environment Minister Hassi also argued that the DiP should be postponed until after the more detailed investigations were complete, and that parliament should have a formal role in the subsequent licensing phases, but these suggestions were rejected by the cabinet.[30] Hassi was successful, however, in insisting that the cabinet approve a repository with sufficient capacity only for the four reactors currently in operation.[31] With this proviso, the DiP was overwhelmingly approved by parliament in May 2001. Only three MPs voted against the DiP, on the grounds that its passage would inevitably pave the way for approval of the fifth reactor. None of them were Greens.[32]

The Greens argued (correctly) that the DiP did not constitute final approval of a repository in Eurojoki, but only permission for more detailed investigations of the bedrock, after which Posiva must apply to the

[28] Author interviews with former Green MPs Heidi Hautala and Pekka Haavisto, Green political advisor Tarja Parviainen, and former Green political advisor Taina Nikula, Helsinki, August 2006.

[29] Author interviews with Green municipal council member Kimmo Tuikka and other past participants in the anti-repository campaign, Äänekoski, August 2006.

[30] Author interview with Taina Nikula, former political advisor to Satu Hassi, Helsinki, August 2006.

[31] For the final text of the DiP, see Finland (2001).

[32] Author interviews with Green League members and Greenpeace activist Harri Lammi, Helsinki, August 2006. Timo Äikäs, Vice President for Engineering for Posiva Oy, confirmed that TVO/Posiva never considered retrievability until parliament demanded it (author interview, Olkiluoto, August 2006). See also Lammi (2009, 74-76).

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government for construction and operation licenses. In fact, however, subsequent developments unfolded precisely as the authors of the Eurojoki agreement had hoped. Almost a year to the day after the approval of the Eurojoki DiP, the parliament approved TVO's application for a fifth reactor by a vote of 107-92, virtually a mirror image of the margin by which the utilities' earlier submission had been defeated in 1993. The Green League withdrew from the government two days later (*Helsingin Sanomat International Edition* 2002a; 2002b). The following year, TVO announced that Eurojoki had been chosen to host the new reactor (*Helsingin Sanomat International Edition* 2003). In the meantime, the Loviisa Energy Centre, having lost its raison d'être, went out of business in 2001 (Tossavainen 2002, 42).

One of the most striking features of the second "fifth reactor" debate was the near absence of the issue of radioactive waste disposal. In 1991–1993, antinuclear activists argued that it was premature to approve a new reactor in advance of a solution to the problem of waste disposal, and the problem was presented as primarily political rather than technical (Lammi 2009, 75). In 2000–2002, by contrast, this hurdle appeared to have been cleared. With a willing host community on board, the still-pending licensing stages elicited little suspense, especially since there was no public disagreement among Finnish experts regarding the viability of geological disposal or the suitability of the Olkiluoto site.[33] Instead, the debate over the fifth reactor was fought over the question of whether the fifth reactor would be a more or less economically efficient part of Finland's national strategy for reducing carbon dioxide emissions, relative to the available alternatives. This framing of the issue was much less favorable to antinuclear activists, and divided the environmentalist community instead of uniting it (Lammi 2009; Berg 2009).

All of these lessons were underscored in 2010, when the Finnish government and parliament approved DiPs for two new reactors, one to be built by TVO at Olkiluoto, and one to be built by the utility Fennovoima, in the north of Finland. A third application submitted by Fortum, the successor to IVO, for expansion of the Loviisa plant was denied. Proponents of the new reactors stressed the need to meet Finland's greenhouse gas reduction targets and reduce fossil fuel dependence on Russia. The opponents' efforts to revive concerns about radioactive waste disposal were unsuccessful, despite the fact that Posiva made clear its unwillingness to store any waste generated by its rival Fennovoima. As in 2002, the Green League, once

[33] For detailed analysis of the elite consensus and its political impact, see Litmanen (2009); Ruostetsaari (2010).

again a partner in the coalition government, opposed the DiP in both the cabinet and parliament. This time, however, the Greens did not resign from the government in protest (*Helsingin Sanomat International Edition* 2010a; 2010b; Kinnunen 2010).

Volunteerism and Partnership: The Swedish-Finnish Models Move to Center Stage

What tentative conclusions can we draw from the Swedish and Finnish experiences thus far? First, siting strategies that build upon preexisting community investment in nuclear power generation are more likely to succeed than those that do not. Previous studies of repository siting have directed attention to the importance of transparent and democratic siting procedures, such as granting veto power to potential host communities. However, there is no evidence yet that these procedures, in and of themselves, are sufficient for success. In both Sweden and Finland, all of the communities that volunteered to host the HLW repository were "nuclear oases," dependent upon nuclear power generation for their economic livelihood. In Finland in particular, the waste disposal authorities were able to convince the majority of the residents of these communities not only that a repository would be safe, but also that resolution of the waste disposal issue was essential to the continued viability of nuclear production, *and* that hosting a repository would be accompanied by the expansion of nuclear power generation as well as the construction and operation of the repository itself. Where candidate sites were chosen on other grounds, such as previous excavation, geological characteristics, and/or population density, this led to the nomination of communities with no prior investment in nuclear power production. In both Sweden and Finland, all such "virgin" communities refused to host a repository, regardless of the nature of the technology or site selection procedures involved.

Second, once agreement with a volunteer community has been reached, the radioactive waste issue loses much of its political force. At the local level, anti-repository activists in *other* potential host communities—even those affiliated with national parties or organizations that oppose nuclear power production—have much less incentive to prolong or reopen the siting process once a willing host community has come forward: from their perspective, the primary danger has been averted. At the national level, the emergence of a community willing to serve as host to a radioactive waste repository undercuts the argument, used so effectively in Germany and the

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United States, that nuclear power is unsustainable and unjust because the community selected to host the nation's repository is unwilling to do so. Instead, the opponents of nuclear power must increasingly turn to much more technical arguments for the postponement of the proposed waste disposal solution. The effectiveness of these arguments will vary with national differences in political structure, geography, divisions in expert opinion, and so forth; but in Finland, at least, technical arguments in favor of further postponement gained little political traction—and this shift took place well before the start of construction.

Third, both cases suggest that solving the waste problem does indeed advance the cause of nuclear power production. Once politicians and the public in Sweden and Finland perceived that the waste problem had been solved, one of the most formidable arguments against nuclear power—the extremely challenging task of safely storing materials that will remain dangerous for tens of thousands of years or more—promptly lost most of its political force, even (in Finland) when the owner of the repository-to-be declared its unwillingness to take in radioactive waste generated by rival utilities. While securing public acceptance for a repository is neither a necessary nor a sufficient condition for the expansion of nuclear power, it is sufficiently important to tip the scales in a close contest.

It remains to be seen how quickly or successfully other democratic governments will embrace the Swedish/Finnish model. Public opinion surveys such as the Eurobarometer consistently indicate that citizens in Finland and Sweden have far more trust in both government and industry than do their counterparts in most other comparable states, a fact that might have contributed significantly to the success of their repository siting exercises. Furthermore, neither Sweden nor Finland began this process already burdened by a protracted battle over an imposed repository site, like Yucca Mountain or Gorleben, into which their governments had already invested vast political and economic capital, or by a history of operational accidents and radiation releases within their own territory. It is also very likely that the opponents of nuclear power will adapt their tactics in response to the Swedish/Finnish model, perhaps by making a far greater effort to organize opposition within "nuclear oases," however difficult this might be, rather than concentrating their efforts on "virgin sites" that are unlikely to be selected in any case.

Nevertheless, the combination of climate change and the Swedish/Finnish model has put the wind to the back of the nuclear industry for the first time in many years, and there are signs that its dual lessons of linking waste disposal to expansion and siting through a volunteerist approach focusing on nuclear oasis candidate sites are quickly becoming the

new common wisdom. In making their decision to move forward with nuclear expansion in the UK recently, the government explicitly linked new construction to resolution of the nuclear waste issue and has launched a volunteer recruitment program in the nuclear region of west Cumbria, home to the Sellafield facility. Indeed, it is quite possible that the simple demonstration effect exerted by the Swedish and Finnish cases—the increasingly widespread perception that the radioactive waste disposal problem can be solved at a relatively modest political cost—may be enough to carry the nuclear industry through a new round of expansion, even in countries that have not begun to implement this model themselves.

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