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Identifying remaining socio-technical challenges at the national level: Canada

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Contents

1. Introduction

This country report on Canada contributes to the InSOTEC research programme's Work Package 1.1 which maps remaining socio-technical challenges to the implementation of geological disposal of radioactive waste in fourteen countries in the EU and North America (www.insotec.eu). The aim of this country report is to provide an overview of the current situation of geological disposal of High Level radioactive Waste (HLW) and Spent Nuclear Fuel (SNF) in Canada. The focus is on the present, but in order to enable an adequate understanding of current developments the report discusses past activities which have directly impacted on present activities. The approach to the past is genealogical, tracing the antecedents of the present rather than trying to capture a particular time in all its complexity.

As a desk-based study undertaken from the UK, by social scientists unfamiliar with Canada, this report relies on material available on line. The stud report draws primarily on documents produced by the actors currently involved with HLW/SNF management, but it also uses social science research publications. The material has been interpreted from a position of anti-essentialist, practice focussed science and technology studies (cf. Callon, Barthes and Lascoumes, 2009; Jasanoff, 2004; Latour, 2005).

As the issue of most interest in Canada at this moment in time and in relation to other national programmes is the geological disposal of HLW and SNF, this report does not discuss the development of centralised disposal of Low Level Waste (LLW) in the Port Hope Area Initiative (www.phai.ca/en/phai-home). Nor do we address the project creating deep geological disposal for Low and Intermediate Level Waste (ILW) at Kincardine, in which the OPG (Ontario Power Generation) and the Bruce County municipalities are collaborating (www.opg.com/power/nuclear/waste/dgr/index.asp), with the technical assistance of the Nuclear Waste Management Organisation (NWMO). Although interesting these two undertakings have, at this point in time, overcome many socio-technical challenges and are progressing according to plan. This does not mean that they will be completed as planned by the implementers, surprises might arise at any time, but it does mean that we cannot, at present, identify any particular socio-technical challenges.

The report starts with a brief overview of the current state of geological disposal of HLW and SNF in Canada. Then we present the actors involved in the Adaptive Phased Management (APM) process, currently adopted as national policy and their present relationships. This is followed by a discussion of the creation of the APM, we look at the technical and social aspects of the policy; the critical views expressed in the public deliberations and the changes occurring when the proposed strategy was established as national policy. Thereafter we account for a critical discourse, conducted by academic social science analysts; beginning in the early 2000s it is elaborating theory-based critiques of APM. However, there appears to be a widening gap between the academic critics and the local communities of which some have submitted expressions of interest in taking part in the APM programme, we look at who is taking part in this geography of the willing. We finish with some concluding remarks and speculate on which challenges might face APM in the near future.

2. The current state in brief

Canada measures its SNF from power plants in 'CANDU fuel bundles', the name referencing the indigenous nuclear power plant technology. Each such bundle is half a metre long and weighs 24 kg; there are photographs and drawings on the NWMO website (www.nwmo.ca). There were approximately 2.2 million spent CANDU bundles waiting to be managed as waste on the 30th of June 2010 (Garamszeghy, 2010). This translates to 44,000 tonnes of heavy metal, according to the same report. 85,000 bundles of spent fuel are added to this annually. Currently the waste is stored in licensed interim facilities at the power plants producing it. When removed from the reactor a bundle is placed in a water filled pool for seven to ten years, while the heat and radioactivity decreases, then it is moved to dry storage. Since 2007 disposing of this waste has been the object of APM, a long term national policy for disposal, based on voluntary siting and public engagement. The NWMO is responsible for the implementation of this 'producer pays' programme which was developed through extensive public consultation and operates with broad social collaboration as the core principle.

APM combines a technical method and a management system. Technically, it pivots on centralised containment and isolation of used nuclear fuel in a deep geological repository. The management system involves phases, each marked by explicit decision making points and with continuing participation by interested Canadian publics. The programme is presented as flexible, making it possible to take advantage of new knowledge or changing societal priorities. An example of the flexibility is that APM provides an option for shallow underground storage at a central site if used fuel would need to be moved from the power generating sites before a deep repository is available. The programme also provides for continuous monitoring throughout implementation and for retrievability during an extended period.

APM was invented by the NWMO in a process of extensive public consultation and deliberation taking place from 2002 to 2005. Initiated by a new law, this process reformulated Canada's management of HLW and SNF, concluding with NWMO recommending APM as national policy. The government adopted APM in 2007 and reconfigured the NWMO into the implementing organisation. From 2007 to 2009 the reconstituted NWMO focussed on creating a democratically acceptable process for site selection, again through extensive dialogue with the public. Through the social engagement process the NWMO arrived at the view that the main concerns were for a safe and secure disposal facility and a site selection process that was grounded in values and objectives that the wider society considered important. A discussion document issued in May 2009 set out the scientific and technical requirements that would guide the selection of an appropriate site and ensure safety. It describes how the site selection process would be done through establishing a partnership with a local community volunteering to host a facility.

To date eleven local communities across Canada have expressed interest in being considered as potential hosts and requested initial screenings, one was ruled out as geologically unsuitable. The remaining ten are in a position to decide whether they wish to continue exploring the possibilities of housing the facility. In the communities wishing to proceed, more detailed feasibility studies will be carried out. The NWMO has decided to close the submission process by the end of September 2012, accepting no more expressions of interest after this date.

3. Context - nuclear Canada

The issue of nuclear waste management in Canada is part of a historical commitment to nuclear power. The nuclear industry is nationally prominent, according to the Canadian Nuclear Association, 15% of the electricity produced is provided by nuclear power plants. Canada is also one of the major worldwide uranium export countries. Geographically the province of Ontario dominates power production with 16 of the 18 Canadian nuclear plants; Quebec and New Brunswick have one reactor each. Canada's uranium mines are located in the province of Saskatchewan; in 2007 they provided 23% of the global uranium production. Canada has developed and commercialised the Canada Deuterium Uranium (CANDU) power reactor technology. Designed in the 1950s and 60s this reactor technology has since been exported to other countries, including China, India, South Korea and Argentina.

There are currently four laws in place governing the sector: the Nuclear Energy Act (NEA) of 1985 regulates the nuclear sector in general, while the Nuclear Safety and Control Act (NSCA) of 1997 directs the activities of the Canadian nuclear industry. The industry is also regulated by the Nuclear Liability Act (NLA) from 1985, accepting civil liability for nuclear damage. The main purpose of the fourth law, the Nuclear Fuel Waste Act (NFWA), was to decide on the management of nuclear fuel waste, the NWMO was established under this law.

A timeline for Canada's nuclear waste related activities spans six decades:

- 1952 AECL (Atomic Energy of Canada Ltd.) created
- 1972 AECL proposes geological disposal for high level nuclear waste
- 1977 AECL selects a site for a Rock Characterisation Facility, public opposition
- 1978 The 'Hare report' is adopted as the Canadian Government's Green Paper on Nuclear Waste Management, establishing geological disposal as national policy
- 1984 An Underground Research Laboratory is officially opened
- 1985 Nuclear Energy Act and Nuclear Liability Act
- 1988 Major public opposition leads to the request for an environmental assessment of geological disposal
- 1989 A review panel led by Blair Seaborn begins the environmental assessment
- 1997 Nuclear Safety and Control Act
- 1998 The 'Seaborn panel' reports, concluding that geological disposal has failed with regard to public acceptability
- 2002 Establishment of the Nuclear Waste Management Organisation (NWMO) under the Nuclear Fuel Waste Act (NFWA)
- 2005 NWMO proposes an approach for the management of used nuclear fuel to the Minister of Natural Resources
- 2007 Government selects Adaptive Phased Management (APM). The NWMO is designated as the implementing body and reformed to this purpose.
- 2011-12 Unsuitability screenings of eleven volunteering communities, one community is ruled out
- 2012 Expression of interest process closes on September 30

This truncated history focuses on HLW/SNF waste management, leaving out other dimensions of nuclear energy production. Such segregation of waste management from the issue of nuclear power in the national energy policy is a topic of contention. Critics view the separation of waste

management in policy making as an expression of the dominance of nuclear industry interests. Durant (2009) discusses how the separation of nuclear energy from waste management was enforced in the public deliberations leading to the NWMO's proposal for APM, despite challenges posed by actors taking part in the consultation process.

4. Actors

As is the case in most countries the key actors in the Canadian program for managing nuclear waste are the government and the power industry. The national government engages with nuclear waste management via the Department of Natural Resources Canada (NRCan). The department website presents NRCan as seeking to 'enhance the responsible development and use of Canada's natural resources and the competitiveness of Canada's natural resources products' (www.nrcan.gc.ca/department/535, 7/6/2012). The online material conveys that the Minister of Natural Resources is responsible for the NFWA and reports to Parliament.

The Nuclear Fuel Waste Bureau (NFWB) was created in 2002 to support the Minister of Natural Resources in overseeing the implementation of the long-term nuclear fuel waste management in accordance with the NFWA. The web page states that the NFWB objective is to 'ensure that the long-term management of nuclear fuel waste will be carried out in a comprehensive, integrated and economically-sound manner' (www.nrcan.gc.ca/energy/sources/uranium-nuclear/nuclear-fuel-waste-Bureau/1356, 7/6/2012). The NFWB meets with stakeholders, involves with the auditing of programs, provides oversight, interacts with Aboriginal groups and keeps the public informed.

The actors visible today were brought together in new ways as the creation of APM reconfigured previous relationships. In the beginning, 2002, a techno-scientific vision still dominated the field with a historically established, techno-centric, approach to HLW/SNF management, developed over the decades by the government and the nuclear industry through a few key actors, most importantly the AECL. Founded in 1952 the Atomic Energy of Canada Limited (AECL) a government owned corporation was a key actor for decades (www.aecl.ca/Default.aspx, 6/6/2012). On the website the AECL describes itself today as 'Canada's leading nuclear science and technology laboratory' (www.aecl.ca/About.htm, 7/6/2012). The AECL's present involvement with nuclear waste management is described as implementing a 'sub-activity' with oversight from NRCan. The AECL runs two programmes dealing with: '(i) legacy wastes resulting from more than 60 years of nuclear research at Atomic Energy of Canada Limited sites, (ii) historic wastes at sites across the country including the Port Hope area of south-eastern Ontario' (www.aecl.ca/Programs/Program_Activities/Nuclear_Environmental_Stewardship.htm, 7/6/2012). This is a different role from what it used to do. It was AECL who first identified the need to deal with nuclear waste in Canada, proposing deep geological disposal as early as 1972. According to Durant and Stanley (2009) the AECL produced the first statement on Canadian nuclear waste disposal intended for wider distribution. The agency embarked on a programme of technical research and development, establishing laboratory facilities above and below ground. In 1978 a joint statement of the governments of Canada and Ontario directed AECL to develop the concept of deep geological disposal of nuclear fuel waste. In the 1980s public opposition to the work of the AECL grew and eventually prompted the government to request an environmental assessment of the geological disposal concept. In 1988 the federal Minister of Energy, Mines and Resources referred the AECL concept for public review under the Environmental Assessment and Review Process Guidelines Order. An eight member panel, led by Blair Seaborn, was asked to, among other things to: review the

concept; establish a review group of independent experts to examine the safety and scientific acceptability and to review a broad range of policy questions (Nuclear Fuel Waste Management and Disposal Concept, 1998). After conducting a review that included both scientific scrutiny and public views and criticism the 'Seaborn panel' concluded that:

> *From a technical perspective, safety of the AECL concept has been on balance adequately demonstrated for a conceptual stage of development, but from a social perspective, it has not. (Nuclear Fuel Waste Management and Disposal Concept, 1998: Executive Summary)*

The panel elaborated:

> *As it stands, the AECL concept for deep geological disposal has not been demonstrated to have broad public support. The concept in its current form does not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel wastes. (Nuclear Fuel Waste Management and Disposal Concept, 1998: Executive Summary).*

That the environmental assessment review panel reached the conclusion that the concept was not fit to go ahead could be considered a major criticism of the agency in charge. The current, marginal role of the AECL in SNF geological disposal could be seen as a direct consequence of their failure to develop a socially viable programme in the decades that it spent working on the concept.

In response to the Seaborn panel's conclusions and recommendations the Canadian government created a new law, the NFWA which also established a new actor responsible for developing nuclear waste management in a socially acceptable manner – the NWMO. The NWMO was set up and fully funded by the nuclear industry, but regulated by the federal government. Its 2002 mandate was to study alternatives for managing nuclear fuel waste, in order to determine and recommend the best approach. It was required to assess at least three alternatives: interim storage at site of production; centralised interim storage and geological disposal. The original brief was to conduct a study setting out proposed approaches and assess them from a variety of dimensions – ethical, social and economic, as well as technical. The NWMO was then to present a recommendation to the Canadian government as to which of these, or any other approach, should be adopted. It was required to consult the general public, including Aboriginal peoples, on each of the proposed approaches. The NWMO was also required to create an Advisory Council which, comprising 'accomplished Canadians', was to examine and provide written comments on the NWMO's work. The 2002 annual report explains that the Advisory Council identified a number of priorities to attend to in the process, for example, it told the NWMO that it needed to assess the management options 'within an ethical and social framework' (NWMO, 2003: 6).

Although the NWMO was a newly constructed actor social analysts criticised its close ties to the nuclear industry and ideological affinity with it. Johnson (2009) explains that a large number of the experts populating the NWMO came from the AECL, the OPG (Ontario Power Generation) and the CNSC (Canadian Nuclear Safety Commission). She further criticises the NWMO's control of the public consultation process leading to APM with regard to methods, topics and reporting for constraining the principles of inclusion, procedural equality and public reasoning.

After the Canadian government's adoption of APM as national policy the NWMO was reconfigured to become the implementer. The existing board stepped down, making the implementing NWMO clearly distinct from the previous study organisation. The reconfiguration also entailed major

expansion of the natural science and engineering research and development activities of the NWMO. During the policy invention process these subjects had mainly been addressed through targeted expert input. For the new, implementing NWMO, scientific and engineering knowledge was critical to undertake the required activities. A five-year technical R&D programme supporting APM was developed, focussing on 'used fuel storage and repository engineering, geosciences, and safety assessment' (NWMO, 2008: 23). In addition, the new role brought novel tasks, the NWMO assumed the responsibility for directing and managing all technical research and development programmes on used nuclear fuel, taking over more than 20 multi-year contracts from OPG. The NWMO understood their new mandate to be 'an endorsement of our transparent and collaborative approach to our work' (NWMO, 2008: 16). They set about drafting seven strategic objectives that were 'put forward to Canadians for confirmation' (NWMO, 2008: 12). This and other activities are understood to demonstrate the NWMO's continued commitment to engaging and involving the public in the APM, not only in creating the strategy, but also to implement it. The annual report tells about work furthering the 'relationships with interested organizations, individuals and Aboriginal peoples and sought their views on how APM should be implemented' (op cit.). The NWMO published a concept paper titled 'Preparing for Implementation', asking people to comment. Another novelty was anticipating future licensing processes and to this end initiating a dialogue with the CNSC.

As the implementer of the APM the NWMO has to adhere to the regulatory requirements of the CNSC, an agency in the Natural Resources Canada radioactive waste management portfolio. This regulatory body was created in 2000 through the Nuclear Safety and Control Act, replacing the AECB (Atomic Energy Control Board). On the website the CNSC mandate, covering four major areas, is described as:

- *regulation of the development, production and use of nuclear energy in Canada to protect health, safety and the environment*
- *regulation of the production, possession, use and transport of nuclear substances, and the production, possession and use of prescribed equipment and prescribed information*
- *implementation of measures respecting international control of the development, production, transport and use of nuclear energy and substances, including measures respecting the non-proliferation of nuclear weapons and nuclear explosive devices*
- *dissemination of scientific, technical and regulatory information concerning the activities of CNSC, and the effects on the environment, on the health and safety of persons, of the development, production, possession, transport and use of nuclear substances* (www.nuclearsafety.gc.ca/eng/about/mission/index.cfm, 7/6/2012)

On this website we also find instructions for potential licensees, explaining that there are four main steps in the licensing process for any nuclear facility, including geological repositories: first the applicant submits a license application, second an Environmental Assessment is carried out, third technical assessments are done and finally CNSC renders its decision. Normally the CNSC decides whether an Environmental Assessment (EA) is required for a proposed nuclear project, but in the case of the APM process the Canadian Environmental Assessment Act (CEAA) prescribes that an EA is to be carried out. A proposal for a geological disposal repository project would be required to undergo a Comprehensive Study under the CEAA since it would be a large project with potential for significant adverse effects on the environment and could also generate public concerns. The CNSC would submit a Comprehensive Study to the Minister of the Environment who would issue an environmental assessment decision statement, including the opinion of the Minster on the relative value of the project in light of its anticipated environmental effects. There is another possibility,

instead of the CNSC undertaking a Comprehensive Study to fulfil the regulatory requirements the Minister can order an assessment by a Review Panel. Appointed by the Minister a review panel has 'the unique capacity to encourage an open discussion and exchange of views' (www.acee-ceaa.gc.ca/, 11/6/2012). Allowing all Canadians to present evidence, concerns and recommendations at public hearings, the panel then submits recommendations to the Minister and to the responsible authority. In the field of radioactive waste management the power of review panels to shape national strategies was demonstrated by the Seaborn panel.

If a proposed geological disposal facility would pass an Environmental Assessment, or a Review Panel, there are a number of regulatory frameworks that would come into operation. The CNSC has developed a Regulatory Guide for the NWMO that provides the basis for the formal assessment of the safety of APM's different aspects, for example one section addressing 'the combination of natural and engineered barriers and operational procedures that contribute to safely managing the waste' (CNSC, 2006: 6). One element identified in the Regulatory Guide is developing a Safety case:

> *Demonstrating long term safety consists of providing reasonable assurance that waste management will be conducted in a manner that protects human health and the environment. This is achieved through the development of a safety case, which includes a safety assessment complemented by various additional arguments based on:*
> *1. Appropriate selection and application of assessment strategies;*
> *2. Demonstration of system robustness;*
> *3. The use of complementary indicators of safety; and*
> *4. Any other evidence that is available to provide confidence in the long term safety of radioactive waste management. (CNSC, 2006: 9.)*

The guide pertains to any facility in which nuclear waste may be held, e.g. interim storage. Parts of the regulatory framework that will apply to a future geological disposal facility will already be in operation regulating facilities at which nuclear waste is presently stored. One such facility is the Chalk River Laboratories (CLR), owned and operated by AECL.

The CLR website informs the reader that it is 'both a national research facility and an international production center for medical radioisotopes' (nuclearsafety.gc.ca/eng/mycommunity/facilities/chalkriver/chalkriver_facilities.cfm, 12/6/2012). Further, it states that activities at CLR include services and development related to the nuclear industry, but also scientific research in physics, metallurgy, chemistry, biology and engineering. Over 200 researchers, ranging from professors to students, use the CLR each year. CLR is a key actor in Canada's Nuclear Legacy Liabilities Program, the strategy for dealing with nuclear waste stemming from 60 years of research (www.nuclearlegacyprogram.ca/en/home_en.html). Some of the legacy waste is HLW and will be disposed of in a geological repository, but currently this waste is stored at CLR, the Whitehall Laboratories and Douglas Point.

The SNF comprising the main bulk of waste heading for geological disposal, is at present stored by the producers: OPG, Hydro Quebec and New Brunswick Power. On its website OPG informs the public that it 'operates three facilities for the interim management of nuclear waste generated by OPG's 10 nuclear reactors and Bruce Power's eight nuclear reactors' (www.opg.com/power/nuclear/waste/, 12/6/2012). The facilities – Western, Darlington and Pickering Waste Management Facilities – are licensed and monitored by CNSC. Hydro Quebec has one nuclear power station - Gentilly-2, where '[I]rradiated fuel removed from the reactor spends at

least seven years in the adjacent storage pool before being stored in CANSTOR dry storage modules located inside the generating station's security perimeter' (www.hydroquebec.com/generation/centrale-nucleaire/gestion-dechets.html, 12/6/2012). The CANSTOR modules are being added to when the need arises. New Brunswick (NB) Power operates one nuclear facility, a factsheet downloaded from the Point Lepreau Generating Station website informs the reader that:

> *[A] fuel bundle typically stays in the reactor between six months to 18 months. This irradiated fuel (or spent fuel) is removed from the reactor via automated fueling machines and stored underwater in a spent fuel bay. The fuel is stored in water for two reasons: the water is a good shield from radiation, and the water carries the heat away from the irradiated fuel bundle. After seven years, the radioactivity and heat have decreased enough to allow the irradiated fuel to be transferred to dry storage in concrete canisters above ground. The canisters are on the property of PLGS and are constantly monitored. (www.nbpower.com/html/en/about/operating/nuclear.html, 12/6/2012)*

The three nuclear power plant owners are the main funding bodies of the NWMO and the APM program, paying annually into segregated funds.

We also found traces of actors who are critical of nuclear power in web archives from NWMO's consultation. The process included engagement with critics and the records show the involvement of NGOs, such as the Campaign for Nuclear Phase out (CNP), a coalition body founded in 2003 by more than 300 public interest organisations opposing nuclear power with a national office in Ottawa (www.cnp.ca/main/, 12/6/2012). Another critical NGO is the Canadian Coalition for Nuclear Responsibility. Founded in 1975 the CCNR conducts research on nuclear energy issues emphasizing the uncertainty of knowledge claims put forth by the nuclear industry. In 2011 their conclusion regarding all proposed means of radioactive waste disposal was that:

> *The word "disposal" has no scientific definition. The human race has never successfully disposed of anything. Many people believe that nuclear power should be phased out in order to stop producing any more of these indestructible radiotoxic materials. Nuclear wastes that already exist should be carefully guarded and monitored. It is irresponsible to place these wastes beyond human control in the absence of a genuine proven solution. (www.ccnr.org/GE_NWMO_ITK_Questions.pdf, 12/6/2012)*

In addition various other organizations, such as Greenpeace, the Sierra Club and Energy Probe are involved in the Canadian anti-nuclear movement and critical of the NWMO as well as of APM, which they view as pivotal for the continuation of the nuclear energy programme.

The establishment of APM as national policy reconfigured the relationships between actors with regard to radioactive waste and each other. The implementation of APM has brought new actors forward in the voluntary siting process. By the end of 2011 ten localities had expressed interest in learning more about APM and take part in initial screenings. One of them were considered geologically unsuitable (Red Rock, Ontario), but the remaining nine (Creighton, SK; Ear Falls, ON; English River First Nation, SK; Hornepayne, ON; Ignace, ON; Pinehouse, SK; Schreiber, ON, Nipigon, ON; Wawa, ON) can progress to the next stage, would they so wish. In 2012 an initial screening of the municipality of Brockton found that it too can participate further if it decides to do so (www.nwmo.ca/sitingprocess_whatsnew, 12/6/2012). The NWMO announced that it will close the

submissions of expressions of interest on September 30 1012 (www.nwmo.ca/sitingprocess_suspensionofexpressionsofinterest, 12/6/2012) and is ready to move on to the next step – feasibility studies in the local communities which choose to move forward with the process. These studies will involve NWMO scientific staff and contractors with specific expertise. The use of contractors is already established practice, expert businesses were commissioned to conduct the initial screenings and prepare the reports presenting the findings from the evaluations of local geologies against set criteria.

List of key actors:

- NWMO (Nuclear Waste Management Organisation), implementer of APM; created and defined through NFWA 2002; financed by segregated funds from nuclear waste producers; reports to national government.

- Advisory Council to NWMO, comments on NWMO activity and future plans to the Minister of Natural Resources.

- CNSC (Canadian Nuclear Safety Commission), regulator

- NFWB (Nuclear Fuel Waste Bureau) body supporting the Minister of Natural Resources in overseeing the implementation of APM.

- NRCan (Department of Natural Resources Canada), the government branch responsible for nuclear waste.

- Nuclear waste producers – Ontario Power Generation, Hydro Quebec, NB (New Brunswick) Power

- Local communities passing the initial screening criteria.

5. Creating APM (Adaptive Phased Management)

APM was invented in a process starting in 2002 when the newly created NWMO was mandated to study all aspects, social, ethical and technical, of SNF management through: deep geological disposal in the Canadian Shield; storage at nuclear reactor sites or centralized storage, above or below ground. The study was to be submitted to the Minister by November 15, 2005 (NWMO, 2003). The NWMO started out with a vision for creating a way to ensure 'the long-term management of Canada's nuclear waste in a manner that safeguards people and respects the environment, now and in the future' (NWMO, 2003:5). They wanted 'to develop collaboratively with Canadians a management approach for the long-term care of Canada's used nuclear fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible' (op cit). In addition to stating its vision and purpose the first Annual Report, the NWMO declared the organisation's commitment to conduct with 'openness, honesty and respect for all persons and organizations with whom we deal' (op cit.). The NWMO would also pursue the best knowledge, seek the participation of all interested communities and communicate actively to facilitate constructive dialogue. They would commission additional work where they identified need for more knowledge,

thereby ensuring that they could study different approaches comprehensively and take advantage of new knowledge, both nationally and internationally.

As mentioned above, the creation of the NWMO was a consequence of the Seaborn Panel finding that AECL's concept for geological disposal of SNF was socially unacceptable. The government responded with the NFWA bringing the NWMO into being and providing it with a mandate. In the first NWMO Annual Report the president narrated continuity with the past in explaining that the NWMO would build on previous work, including the 'Seaborn Panel', which had identified criteria for evaluating the safety and acceptability of long-term nuclear waste management in general.

5.1 Engaging society

The NWMO started out with talking to a broad range of actors in Canadian society, including people directly concerned, experts and policy makers. The 2002 Annual Report presents these as preliminary conversations, assisting the formulation of a work program. From this initial work the NWMO learned about the importance of having a sophisticated website, enabling public involvement and to share all information available. After setting up the website the next activity was to commission public opinion research with 14 discussion groups across Canada in order to 'provide some benchmark information on perspectives of the Canadian public' (NWMO, 2003:15). This provided information allowing the NWMO to design their study. The 2002 Annual Report outlines the three phases of the work plan: Phase one aimed to provide the public with opportunities to shape the work plan and learn about the NWMO's mandate. Phase two was dedicated to in-depth exploration of the issues identified in phase one and to generating new questions. Phase three focused on reflection, drawing conclusions and presenting the conclusions to the government.

The 2003 annual report provide a narrative about how the NWMO carried out the plan developed in the first year. They designed a range of initiatives to involve 'the general public, nuclear site communities, aboriginal communities, and individuals who bring to the study their experience and expertise in areas of social, economic, scientific and technical disciplines' in the process of developing a strategy for managing Canada's SNF (NWMO, 2004: 12). A plan was developed to explore the 'values, concerns and expectations of Canadians at each step along the way' (op cit). Over the first six months of the year the NWMO had engaged in face-to-face interaction with representatives of different local groups on 250 occasions. This contributed to the creation of an analytical framework for assessing different management approaches. They thanked the Advisory Council for having provided valuable advice regarding the publication of a 'roadmap' for the future work on the website launched in January 2003. The site was also to be used as a repository for all documentation produced for, or on behalf of, the NWMO

In 2003 NWMO produced their first discussion document which, among other things, raised ten key questions and invited 'Canadians to reflect on the complex issues posed by used nuclear fuel, and to provide their perspectives on various approaches for its long-term management and how those approaches should be evaluated' (NWMO, 2004: 14). The NWMO also asked people if the problem was correctly described; if the appropriate options were being considered; if the right questions were being asked and if their procedures were comprehensible. To elicit public engagement they used a number of techniques, e.g. national citizens' dialogues and qualitative focus groups. They also commissioned nation-wide surveys and telephone surveys which taught them that the management of nuclear waste was not an issue occupying most Canadians, but when prompted people did rate the issue as very important. Most people did not feel that they knew very much about the issue and they had not heard about the NWMO. The Advisory Council suggested that the NWMO would keep a

record of people's interest and knowledge throughout their process of public information and engagement. The NWMO lists the topics on which they commissioned papers, first were 'guiding concepts', examples are 'sustainable development' and 'adaptive management'. The second category was 'social and ethical dimensions', third came 'health and safety'. The fourth topic was 'science and environment', fifth 'economic factors' and the sixth 'technical methods'. Topic number seven was 'institutions and governance' and the final, eight, commissioned topic was 'workshop reports'. The workshops reported on are also brought to the fore in the annual report, there were for example, a workshop examining technical aspects of nuclear fuel waste management; a workshop discussing environmental aspects of used nuclear fuel and a roundtable of ethicists.

The NWMO also interacted with Aboriginal representatives; holding meetings with elders and traditional knowledge holders to explore whether indigenous knowledge could help guide the study. This led to contact with five national Aboriginal organisations who they would continue to work with over time. In addition the NWMO initiated dialogues with people who live in communities already hosting nuclear operations, looking to draw on their knowledge and experiences. They also met with government bodies on all levels, ranging from local elected officials to provincial and federal agencies. In 2003 the NWMO interacted with the 173 organisations and the Scientific Review Group who had worked with Blair Seaborn on the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel. They travelled to visit Canada's seven nuclear reactor sites and talk with the energy corporations, who as owners of used nuclear fuel, were understood to have important expertise and knowledge acquired through years of managing it. The waste owners made their technical research available as a resource for the NWMO. This body of work underpinned the options the NWMO were to look at in accord with the NFWA. The waste owners also provided the NWMO with commissioned work which they submitted for third-party review. The final activity of 2003 was to convene a 'Scenarios Team' who was to imagine and explore which conditions may be facing nuclear waste management in the future. This team, of 26 people with different backgrounds, was to consider scenarios of different temporal scope, ranging from 25 to 10,000 years.

2003 was also the year when the NWMO developed the underpinning for their comparative assessment of different radioactive waste management approaches. By then they had learned that it was important to consider the impact of decisions on the well-being of future generations, including a sense of equity in the cost and benefit sharing across generations' as well as across localities. Other aspects in need of address were the uncertainties associated with making predictions about the long-term performance of any management approach and the abilities of future societies to address potential issues arising. Further they had realised that, while science and technology are important, they cannot be the only basis for decision-making. The NWMO found that they had to take both quantitative and qualitative costs, benefits and risks into account, as well as consider established social institutions, rules, regulations and systems. The list closes with acknowledging the value of flexibility.

As could be expected 2003 was the year when the NWMO assessment process really took off, after commencing in 2002. In 2004 the process was brought to its scheduled conclusion with numerous events and ample feedback, all posted for public access on the website. The 2004 Annual Report shows how important it was to the NWMO to demonstrate that they were not only talking to the public, but also listening and adjusting their thinking accordingly. They arranged numerous events throughout 2004, for example, a 'Citizen's Dialogue' gathering 462 members of the public to learn about their values and expectations with the ambition to understand how 'the public at large approaches the complexities involved in the long-term management of used nuclear fuel' (NWMO,

2005: 12). This event was temporally and spatially distributed, taking place between January and March in twelve locations across the country. Another set of events brought together people who had a past involvement with the issue of nuclear waste. In addition to face-to-face meetings with differently selected participants the NWMO also arranged moderated dialogues on the web. One such e-dialogue was conducted by invited panellists and attracted a virtual audience of about 350 people. Another digital activity was organising e-roundtables, aimed at a younger audience. Between September and December 2004 the NWMO arranged 87 public information meetings and 33 public discussions across Canada attracting about 900 people. On this nationwide tour they made an effort to visit localities hosting nuclear facilities and interim waste storage, but also to respond to requests for presentations by community groups and local authorities. The NWMO received more than 110 written submissions from individuals, all made public on the website. They commissioned more public opinion research, e.g. a telephone survey of 1900 people invited to comment on the first discussion document. They surveyed 700 people living close to nuclear plants. They also commissioned focus groups, approaching the issue of public opinion qualitatively. In addition they posted surveys on their website for any interested visitor to participate. In 2004 they also convened smaller meeting and workshops with particular groups, e.g. practitioners in sustainability and waste management from the private sector and anti-nuclear organisations. They continued to update the government on their study through meetings, written briefings and formal workshops. They also produce an extensive information material aimed at different audiences on different media e.g. DVDs, electronic newsletters, advertising and public media appearances.

The comparative assessment of the possible management approaches entered a new phase later in 2004 as activities began to reveal 'a shared vision and common ground' (NWMO, 2005: 21). The ten key questions presented in the first discussion paper turned out to encompass what the public, stakeholders and experts considered priorities. Aspects emphasised in the dialogues were the advice to adopt a staged approach, allowing future generations to have options and to monitor emerging options, avoiding technical lock-in if better methods would arrive in future. Ensuring the strength and efficacy of oversight and monitoring of regulation compliance and the continuing of efforts to inform and involve citizens in the process also featured prominently. The NWMO recognised that the main priority in developing a policy was to ensure safety from harm. They understood this public demand as not as arising 'from a sense of fear, nor from an expectation of a risk-free world. Rather, it arises from a sense of responsibility to this generation and to future generations to take the necessary precautions' (ibid: 22). The NWMO identified a need to clarify the nature of the hazard, as it can be quite complex.

All reports submitted to the NWMO were posted on the website (where they remain, available to the public). The review of the technical research, received from nuclear waste owners, by a third party, examining the 'appropriateness of key engineering design assumptions and the cost estimation process' (ibid: 24) was also posted on the website. The reviewers found that the technical designs and economical calculations were sound and appropriate and the NWMO subsequently judged the existing knowledge to form a sound basis for the analysis of the three technical methods they were required to assess. The annual report details the assessment by a multidisciplinary team who found that each of the options had specific and different strengths and limitations and that no 'method perfectly addresses all of the values and objectives important to Canadians' (NWMO, 2005: 25). With regard to storage at reactor sites they found that advantages included access to existing on site expertise and no need for transport, while some of the limitations are that isolation depends solely on built facilities and host communities did not participate in the original siting decisions. Considering centralised storage some advantages were that the siting decisions were based on suitability for the

purpose and that it could be achieved with community participation. However, there were limitations, such as transportation which carried risks and costs and facilities could also be vulnerable to extreme natural events. Finally, the NWMO found that a deep geological repository had advantages, for example, low long-term administrative cost and isolation relying on a combination of natural and built features. Limitations included not knowing how it would work over thousands of years and reduced adaptability/flexibility.

In September 2004 the NWMO released their second discussion document called 'Understanding the Choices', presenting the findings from the public engagement and how the dialogues informed the framework used in the assessment. The document also introduced a preliminary assessment of the options and an implementation plan, inviting the readers to comment. The Annual Report explains how the discussions with the public made them begin to think about a phased approach, comprising storage for a period of time, allowing for new knowledge and technology to emerge and a future development of geological disposal.

The material made public on the NWMO website, including the Annual Reports, demonstrate how the process evolved over the three years of study and deliberation. It is clear that the extensive public engagement and active elicitation of as many different views and concerns as possible impacted on the thinking of the committee. In the final annual report they state that:

> *We have been persuaded of the need to look beyond the three distinct technical methods defined in the Nuclear Fuel Waste Act (NFWA), to design a full management approach. We have studied each of the three methods in the NFWA – deep geological disposal in the Canadian Shield, storage at nuclear reactor sites, and centralized storage – and we believe that all three offer safe, secure technologies for the long-term management of used nuclear fuel. /../we believe the most profound challenge lies not in finding an appropriate technical method, but in the manner in which any of the management approaches is implemented. /.../We will be considering the possibility of tailoring a fourth approach that might offer a preferable course, enabling this generation to take responsible steps forward in a way that ensures public safety, respects emerging science and preserves opportunity for future generations to shape decisions in the years to come. (NWMO, 2005: 36)*

The NWMO reports also tell a story about a performance, about making visible that social aspects of waste management were being thoroughly addressed and allowed to inform future strategies, a demonstrated difference from the work by the AECL in previous decades. Populated by people with senior management experience in the nuclear industry and the government the NWMO was able to forcefully articulate a re-orientation of Canadian nuclear waste management. Embodied in the NWMO the new approach emphasised listening and learning to make long-term SNF disposal a democratic process.

In November 2005 the NWMO submitted its final report, proposing APM, designed to benefit from the advantages of the three options originally assessed, recognising that they are not necessarily mutually exclusive, but can be combined to ensure maximum safety and flexibility. APM has three phases:

- *Phase 1: Preparing for Central Used Fuel Management*
- *Phase 2: Central Storage and Technology Demonstration*
- *Phase 3: Long-term Containment, Isolation and Monitoring.* (NWMO, 2005a: 24)

The first two phases are estimated to last for 30 years each and phase three will continue indefinitely. Each phase comprises a number of activities, examples from phase one are: to maintain storage and monitoring of used fuel at nuclear reactor sites; to develop with citizens an engagement program for activities such as design of the process for choosing a site, development of technology and key decisions during implementation; to select a central site that has rock formations suitable for shallow underground storage, an underground characterization facility and a deep geological repository and Continue research into technology improvements for used fuel management (NWMO, 2005a: 24).

In phase two some activities might be (depending on what happens during phase one):

- *If a decision is made to construct shallow underground storage, begin transport of used fuel from the reactor sites to the central site for extended storage.*
- *If a decision is made not to construct shallow underground storage, continue storage of used fuel at reactor sites until the deep repository is available at the central site.*
- *Conduct research and testing at the underground characterization facility to demonstrate and confirm the suitability of the site and the deep repository technology* (NWMO, 2005a: 24).

Activities in phase three, beginning 60 years after phase one commenced, will aim for the long-term containment and isolation of the waste, possibly in deep geological repositories. Depending on decisions and developments in phases one and two some activities in phase three might be to: retrieve and repackage used fuel into long-lived containers if waste is stored in shallow underground facilities, if it is stored at reactor sites it would need transport to the central facility for repackaging. An important aspect in the case of deep geological disposal would be to engage citizens in on-going monitoring of the facility.

The three years of work by the NWMO reconfigured the relationships of technical and social dimensions of radioactive waste management. The technically led concept of geological disposal, which had failed due to neglect of the social, was repositioned in relation to a new social framework.

5.2 Engaged critics

Canada was not as united around APM as the NWMO final report indicates. The documentation shows that the Sierra Club held a Roundtable in response to the NWMO's final draft in 2005, at which a number of concerns were raised. Most pressing was the issue of a disconnection of nuclear waste management from the power generation that produces the waste. In the eyes of the Roundtable attendants and their constituencies there was a basic flaw in the conception of the NWMO and its brief: 'A management approach and method of analysis that continues to be predicated on the decoupling of the production of waste from its responsible management cannot, in the opinion of the Roundtable, be considered "socially acceptable"' (Sierra Club, 2005). The Roundtable argued that a socially acceptable process ought to 'involve inclusion and consideration of the nuclear fuel chain, from cradle to grave, in the definition of the problem posed by nuclear fuel waste management, in the articulation of management options, and in the assessment of these options.' (Sierra Club, 2005: 6-7). Not all Canadian were committed to nuclear energy as national policies indicate.

Although the Roundtable considered the NWMO as having conducted an innovative public engagement programme it found the representation of Aboriginal people to be poor, judging the report 'vague and condescending', to simply summarise differences in opinion in civil society

'without attempts to resolve them, transparently incorporate them into their analysis, or explanation how these views affect their study' (Sierra Club, 2005: 8). These and further criticisms of the NWMO's draft final report provided the basis for a number of recommendations to the NWMO and to the Canadian Parliament. Most importantly the Sierra Club Roundtable recommended that Parliament should reject the NWMO's proposal for APM to instead 'immediately undertake a comprehensive public parliamentary review of the energy policy in Canada, including provincial, municipal and private authorities and civil society' (ibid: 14) which should include consideration of the entire nuclear fuel chain, the future role of demand reduction efforts and the role of alternative energy sources.

There is no sign that the Sierra Club's Roundtable, or any other opposition, had much impact on the decision making, after submitting its final report to the government in November 2005, the NWMO was appointed implementing body of the nuclear waste management strategy by the Governor in Council in 2006 (NWMO, 2007). At this point in time the NWMO changed people in the lead; replacing those who were committed to APM after spending three years creating it. The new team was mandated to implement any strategy the government would choose. The NWMO reorganised internally in preparation for its new task by, among other things, strengthen the social science team and the technical expertise. Waiting for the government to make its decision the NWMO continued to communicate with the publics it had constituted in the study, gather information and monitor progress made with nuclear waste management internationally. In June 2007 the Canadian government decided to adopt the proposal for Adaptive Phased Management as the national strategy for the long-term management of nuclear waste.

5.3 Mission creep?

The reconfigured NWMO continued the publication of documents online and we can see how the content of reports shifted with the new mandate. The 2007 Annual Report begins with presenting the APM visually as a technical and social coupling. To the left of the graph is the 'technical method' comprising 'Centralized containment and isolation of used nuclear fuel in appropriate geological formation', 'Continuous monitoring' and 'Potential for retrievability'. On the right hand side is the 'management system' with six components: 'Collaborative decision-making', 'Phased with explicit decision points', 'Continuous learning & adaptation', 'Open, inclusive & transparent', 'Engagement focused in 4 nuclear provinces (ON, QC, NB, SK)' and 'Seek informed, willing host community' (NWMO, 2008: 6). The two lists, in different colours (grey and blue) join in the middle. There was no fixed timeline, but the NWMO would work through three phases with different emphases: first on the collaborative design and implementation of a process for selecting a site for a centralised facility. When a fully informed community had volunteered site characterisation would take the centre stage and eventually the construction process would begin. In the 2008 Annual Report the visual representation of the APM has undergone some changes. On the left, the technical method side, the first item has changed to: 'Centralized containment and isolation of used nuclear fuel in deep geological repository' and a fourth element had been added: 'Optional step of shallow underground storage' (NWMO, 2009: 6). The management system on the right hand side had undergone more substantive changes, now there were five items: 'Flexibility in pace and manner of implementation', 'Phased and adaptive decision-making', 'Responsive to advances in technology, research, Aboriginal Traditional Knowledge, societal values', 'Open, inclusive, fair siting process - seek informed, willing host community' and 'Public engagement and site selection focused in four nuclear provinces (NB, ON, QC, SK)' (op cit). The 2008 report includes more discussion of the technical and natural science aspects of the APM than previous annual reports.

The acquisition of the science and engineering projects appears to have caused mission creep:

> *The NWMO's Technical Research and Development program is supporting the implementation of Adaptive Phased Management and the collaborative design of a siting process for a deep geological repository.* (NWMO, 2009: 25)

This reads as a full-on commitment to geological disposal, something that the NWMO's idea of APM was designed to avoid. However, as was explained in the work leading up to the APM the science and engineering communities considered the entire consultation process to be a waste of time because they found all options other than geological disposal, to be unfeasible. Now the science and engineering research assimilated into the NWMO seems exclusively orientated towards geological disposal, having:

> *… completed an evaluation of what the load would be on a copper container under repository conditions. The CANDU bundle stress model was improved, and a database on thermodynamic modeling of chemical species in a vault and geosphere was developed.* (NWMO, 2009: 25)

While the engineering research explored the waste form and the containers, geologists interrogated the rock:

> *Thermal-mechanical analyses of a deep geological repository in sedimentary rock using a horizontal tunnel placement method for used fuel containers were completed. Microbial studies under various buffer densities and intermediate groundwater salinity values suggest limited microbial viability in a deep geological repository at lower groundwater salinities compared to previous studies. In the geoscience field, the NWMO prepared preliminary geo-scientific criteria for initial evaluations of potential candidate sites for a deep repository.* (NWMO, 2009: 26)

Overall the research undertaken by the NWMO was now expected to continue along the geological repository path:

> *In 2008, the NWMO developed plans to initiate an update to the conceptual design and cost estimate for a deep geological repository and used fuel transportation system. This work will be done over the 2009 to 2011 period. The focus of our research and development in 2009 will be to continue to develop and evaluate conceptual designs for a deep geological repository, and improve our readiness for site evaluations, used fuel transportation and preliminary safety assessments of potential candidate host sites for long-term management of used nuclear fuel.* (NWMO, 2009: 28*)*

The social science research is presented as supporting the NWMO's ongoing dialogue with Canadian citizens and to explore the social issues associated with APM.

In 2009 the APM had become a programme for implementing geological disposal:

> *The first milestone activity in implementing Adaptive Phased Management is the collaborative design of a process to select a site for a centralized deep geological repository. In 2009, the NWMO put forward a proposed site selection process for public comment and*

input. Only after the views that were heard have been fully considered will the process be finalized and the organization takes the next step of welcoming expressions of interest from potential host communities. Following identification of a site in an informed and willing community, we will conduct site characterization research and complete a detailed design and safety assessment for the repository. Construction will occur in a later phase and will take several years after a construction licence is obtained. An operating licence will be required before the facility is brought into service. (NWMO, 2010: 4)

The 2009 Annual Report is structured by 'seven strategic objectives' said to be derived from the NWMO's previous engagement with the Canadian people. These objectives are:

- *Building Long-Term Relationships*
- *Advancing Research*
- *Providing Financial Surety*
- *Reviewing, Adjusting and Validating Plans*
- *Ensuring Good Governance, Oversight and Advice*
- *Building an Implementing Organization*
- *Collaboratively Designing a Siting Process* (NWMO, 2010: 17)

In 2009 the NWMO was also contracted to develop a 'Deep Geologic Repository' for low and intermediate level waste owned by OPG. This project originated in 2001 when the Municipality of Kincardine entered a Memorandum of Understanding to assess the feasibility of a low and intermediate level deep geological repository at the Bruce nuclear site (www.opg.com/power/nuclear/waste/dgr/index.asp).

The 2009 annual report also tells about how the NWMO continued 'to build relationships with representatives of provincial and federal governments to foster greater understanding of our work, build trust and confidence in our processes and activities, and respond to questions about the implementation of Adaptive Phased Management' (NWMO, 2010: 24). This was considered important as APM was an issue stretching across the territories of many government departments. This can be understood as resulting from the NWMO taking on responsibility for the implementation of the long-term objective of geological disposal of all radioactive waste in Canada, low, intermediate and high level, further changing the organisations' character and their relationships with government on different level had to be carefully maintained in order for them to be able to implement anything. The NWMO also signed a Memorandum of Understanding with Natural Resources Canada, clarifying their relationship with Aboriginal people.

The relationship with Aboriginal people figures prominently in the work of the NWMO which is a feature that sets this organisation apart from equivalent bodies in other countries. This focus is partly due to the Canadian recognition of the rights of Aboriginal people and partly to the fact that much of the land on which the siting of facilities for intermediate storage and permanent disposal in a geological repository is possible is Aboriginal territory. In contrast to this uniquely Canadian feature of the NWMO's work, the activities to update conceptual design and develop safety cases for a geological repository echoes work done in other countries. In the annual report for 2009 we can read that the NWMO expects to submit conceptual designs and illustrative safety cases for repositories, both in crystalline and sedimentary rock to the Canadian Nuclear Safety Commission (CNSC) by 2012, for pre-licensing review. Engineering projects were addressing the structural behaviour of copper and steel used fuel containers under repository conditions over the very long term. Important

engineering and geological research had been undertaken in the Underground Research Laboratory (URL) in Manitoba. The geoscientists were preparing for future assessments of potential candidate repository sites in volunteering host communities.

The efforts to 'integrate ethical values and principles into the development of individual policies, plans and operations' (NWMO, 2010: 37) continued. The focus in 2009 was on developing a 'fair, ethical and effective process for selecting a site in an informed, willing host community' (op cit.). This process had so far resulted in four commitments to how a site selection process must work:

1. *The decision by a community to host the site must be informed and made willingly.*
2. *The site selected must meet strict, scientifically determined safety requirements.*
3. *In the interest of fairness, engagement should focus on the provinces directly involved in the nuclear fuel cycle: New Brunswick, Quebec, Ontario and Saskatchewan.*
4. *Communities that decide to engage in the process for selecting a site, as potential hosts, shall have the right to withdraw consistent with any agreements between themselves and the NWMO.* (NWMO, 2010: 57)

2010 saw the final step in the reconfiguration of the NWMO to an implementing organisation, as it became an employer with the associated infrastructure. The NWMO had been transformed, from a small organization established in 2002 to undertake an open-ended study of options, to a corporation with full responsibility for implementing geological disposal, counting over 100 employees and growing. It also looks as if the organisational culture reverted back to that of the previous implementer, AECL, in which the technical concept of geological disposal took centre stage.

6. Critical academic discourse

The apparent mission creep identified above can be understood when contextualised in critical social science discussions. Social scientists critical of the NWMO have published extensively, in Canadian and international academic journals, as well as monographs and edited collections. Conducted within political science, anthropology, science studies and other fields this critical discourse speaks both to the Canadian radioactive waste management process and to international social science analysis of radioactive waste management.

The academic criticism pivots on one major issue: the political hegemony of the nuclear establishment. What may at first glance look like a truly democratic initiative – the creation of the NWMO with a mandate to assess different management options for nuclear waste and outline a strategy for how to implement it in a socially acceptable manner – is actually, according to Durant and Stanley (2009), the latest manifestation of the hegemony of the nuclear establishment. They argue that the fact that the NWMO was staffed predominantly by people from the AECL and the nuclear industry means that it was part of the Canadian nuclear establishment, whose goal is to promote and expand nuclear energy. This was demonstrated by the NWMO following the trajectory of the AECL and the nuclear industry, refusing to challenge the disconnection of waste management from nuclear energy production. According to Durant and Stanley this disconnection is preferred by the nuclear industry who views waste management as a sticky issue that could threaten their growth. What Canadians outside the nuclear energy industry think about this disconnection is not a question that the nuclear industry wants to have explored which is why the NWMO's complicity re-affirmed the hegemony. The NWMO chose to set the limits of the democratic deliberations in this way

regardless of what publics, like the Sierra Club Roundtable, said. Only citizens accepting the separation of waste management from waste production could be heard in the discussion according to Durant (2009).

The dominance of the nuclear establishment in the process of inventing APM was also visible in the constraints imposed on the expression of public opinion and the appropriation of Aboriginal knowledge. Johnson (2009) criticises the construction of the public in the NWMO's consultation process, arguing that representative samples of the population were constructed in ways that marginalised critics of the overall nuclear energy agenda. In addition public surveys and deliberative activities excluded questions about the context for radioactive waste management in national energy policy. Stanley (2009) examines in detail the ways in which the NWMO appropriated Aboriginal knowledge in reports presenting it as being in support of the technical concept of deep geological disposal while accounts from the local interaction of NWMO members and Aboriginal representatives bear evidence of irreconcilable differences. Another issue is the suppression of the voices of Aboriginal communities with negative experiences of the nuclear industry. Stanley (2008) discusses how the residents of Serpent River First Nation told the NWMO about the negative health and environmental effects they suffered after decades of uranium mining, making evident that not all Canadians, nor all nuclear communities, benefitted from nuclear power generation. However, their experiences were edited out from the NWMO's framing of SNF management as a necessary aspect of an industry providing benefits to all citizens. The construction of the Canadian nation and its citizens did not include those suffering negative consequences from any part of the nuclear power chain. More recently academic critics have turned towards the claims made by the NWMO about the ethical implementation of nuclear waste management. Wilding (2012) criticises the ethical framework presented by the NWMO, arguing that being a series of questions it does not constitute a framework that can guide actions. He also argues that it includes criteria that cannot be satisfied, even in principle, such as the consent of future generations.

The criticism of the NWMO's deliberative process deconstructs the narrative of national unity behind the new policy. Critics emphasise the social and discursive continuity of the NWMO with waste producers and the marginalisation of all criticisms of the nuclear industry. Differently from similar processes in, for example the UK, there was no radical disconnection from the industry in the critical revision of strategy in Canada. This goes a long way to explaining the mission creep of APM, from a process continually looking for new knowledge to manage nuclear waste to the stepwise implementation of geological disposal. However, today this is mainly a point of historical interest, APM is in operation and seems to be moving rapidly; local communities have expressed interest and undergone initial unsuitability screenings.

7. A geography of the willing

By mid-2012 eleven local communities had expressed interest in learning more about APM and take part in an initial screening. One of them were considered geologically unsuitable (Red Rock, Ontario) but the remaining ten (Creighton, SK; Ear Falls, ON; English River First Nation, SK; Hornepayne, ON; Ignace, ON; Pinehouse, SK; Schreiber, ON, Nipigon, ON; Wawa, ON and Brockton) can progress to the next stage, would they so wish. To get a better understanding of the local communities willing to embark on APM we look closer at two localities: English River First Nation and the community of Nipigon.

From its website we learn that English River First Nation, located at Patuanak in Saskatchewan, was created as an aboriginal community with the signing of a Treaty in 1906 (www.erfn.net, 2/7/2012). The community comprises seven main reserves: Cree Lake, Porter Island, Elak Dase, Knee Lake, Dipper Rapids, Wapachewunak and LaPlonge. Inhabitants speak a language called Dene and the population is about 1000, whereof 600 live on the reserves. Patuanak is the central locality, close to the Churchill river with a natural environment that supports fishing, hunting and gathering. The website also remarks that there are no paved roads in the area and only one grid road leading in and out of Patuanak. A more common way of travel is by boat, in summer people cross the lake to Ile a la Crosse, in the winter the ice provides a route for snowmobiles.

English River First Nation is not new to the energy sector; it owns Tron Power, a company located in Saskatoon, which delivers a full range of services, including construction, to the mining industries in Northern Saskatchewan. Administratively the community members grant power to an elected Chief and a Council, who govern the land and property of the First Nation. The Chief and Council are the authorized government and legal authority on the English River First Nation reserve. Listing the chief and the council members the website also informs us that councillor Bearnadette Eaglechild is responsible for the relationship with the NWMO. However, the initial screening report is addressed to the chief, Ralph Paul.

The report carried out by the contractor Golder Associates, is prefaced by a letter signed by Kathryn Shaver, 'Vice President APM Public Engagement and Site Selection'. From it we learn that the overall objective of the initial screening is to evaluate a proposed geographical area against a list of five criteria:

1) *The site must have enough available land of sufficient size to accommodate the surface and underground facilities.*
2) *This available land must be outside of protected areas, heritage sites, provincial parks and national parks.*
3) *This available land must not contain known groundwater resources at the repository depth, so that the repository site is unlikely to be disturbed by future generations.*
4) *This available land must not contain economically exploitable natural resources as known today, so that the repository site is unlikely to be disturbed by future generations.*
5) *This available land must not be located in areas with known geological and hydrogeological characteristics that would prevent the site from being safe, considering the safety factors outlined in Section 6 of the Site Selection Document.* (Golders Associates, 2011: 2)

The report divides the English River First Nation reserve areas into three distinct geological regions: the Athabasca Basin defines Region 1; the Canadian Shield Region 2 and the Western Canada Sedimentary Basin Region 3. The screening found that Region 1 and Region 3 failed to meet all the criteria and they were therefore excluded from further consideration. Region 1 had areas with groundwater at repository depth, failing criterion 3; known economically exploitable resources, criterion 4 and known unfavourable geological and hydrogeological characteristics, criterion 5. Criterion 5 also excluded Region 3. However, Region 2, geologically defined as Canadian Shield, meets all the criteria. It contains sufficient land to accommodate surface and underground repository facilities (criterion 1). Enough of the available land lies outside of any protected areas, heritage sites, provincial parks and national parks (criterion 2). The land available also clears criterion 3 in that no groundwater resources had been identified at repository depth. There are sufficient lands free from known natural resources of economic value (criterion 4). Finally, geological and hydrogeological

conditions do not prevent the site from being safe as required by criterion 5. Following the unsuitability screening the English River First Nation community is now in a position to decide whether to progress with APM, this would entail a formal request to be considered for further site investigation, step 3 of the siting process.

In another part of Canada we find a second example of a volunteering community, Nipigon. It is located on the northern most point of Lake Superior, by the Nipigon River that flows from Lake Nipigon to Lake Superior (www.nipigon.net, 3/7/2012). The central locality of Nipigon has 1,718 residents and another 2,713 live within commutable distance. The website points out that Nipigon is strategically located close to the centre of Canada, on the TransCanada Highway. Its role as a transport hub, thanks to the road networks and regional services that converge in the community, is emphasised. Apart from public services Nipigon has a history of forestry and mining and is keen to expand, starting new endeavours in these fields.

Recreational fishing is advertised and promoted on the website; Nipigon claims to be providing Canada's most impressive fresh water fishing, across the lakes and rivers. The waters provide a habitat for brook trout and more than 70 other fish species. Summer activities on offer include boating, hiking, and camping while in the winter visitors are invited to engage in snowmobiling, cross-country skiing, and ice climbing.

On the website the community also tells about the initiative to learn more about Nuclear Waste Management. Nipigon representatives have visited Toronto to meet with the NWMO. The visit, funded by the hosts, included a briefing about the Canadian APM programme and a tour of a facility where spent fuel is kept in interim storage. The photo of the visitors on tour was released 24 October 2011, indicating the Nipigon is currently subject to an initial screening to find out whether the area could be further considered if the community would want that to happen.

These two communities, English River First Nation and Nipigon, are both similar and different, they are small in terms on population, but large with regard to geographic area, they are also geologically similar in that they sit on top of the Canadian shield, conceived of as suitable for deep geological disposal by scientists since the 1970s. Their differences are socio-cultural, English River First Nation is an Aboriginal community, preserving and reproducing a cultural heritage different from the modernity that has generated nuclear energy and its waste. In contrast Nipigon appears to be a product of that modernity, presenting itself as the gateway to a nature that can be exploited in different ways for economic and recreational purposes.

8. Moving towards geological disposal

The APM site selection process is described as 'community driven' which means that it will 'necessarily evolve on timelines determined by communities' (NWMO, 2011: 21). This is mentioned in the context of the introduction of a five-year plan, for planning purposes. The core NWMO strategy for the 2011 to 2015 period is to work with communities who put themselves forward for initial screening:

> *NWMO will work in partnership with them in the delivery of preliminary site assessments over one to two years, examining the feasibility of sites against geoscientific safety criteria and community well-being considerations. The NWMO will work with communities to conduct*

regional studies and expand dialogues to include surrounding communities, Aboriginal peoples and regions that may be affected by the siting of the APM project or the transportation of used nuclear fuel to that location. (NWMO, 2011: 23)

The host community eventually selected will not only provide an important service to the nation and future generations it will also become the location for a new centre of expertise supporting the process. This centre…

> *…will be the home for an active technical and social research and technology demonstration program during this period, involving scientists and other experts in a wide variety of disciplines, including geoscience, engineering, and environmental, socioeconomic and cultural impact assessment. The design details of the centre of expertise would be developed with the community and the surrounding region, with their preferences in mind. The centre of expertise could be designed as a focus for engaging members of the community to learn more about the project, and to view the scientific and engineering work-in-progress involved in site assessment, through public viewing galleries and interactive displays. The centre could be created as a small science centre, highlighting and demonstrating the science and technology being used to determine whether the site is suitable. It may be developed as a meeting place and learning centre for the community, and as a destination that welcomes interested visitors from the region and beyond. (NWMO, 2011: 53)*

The centre will precede the repository by many years and if the site is eventually chosen as the location for it the centre would be expanded. The centre is not the only benefit brought by a repository there will also be significant economic gain, direct employment for hundreds of people for many decades; many more indirect jobs in the region and province, opportunities to 'develop transferable skills and capacities' (op cit). Of course, there are also risks, but to 'minimize social costs and help communities adapt to the opportunities and challenges of the project, the need for assistance, such as job training, affordable housing and infrastructure, would be examined' (NWMO, 2011: 53).

The technical research programme is explained as having two principal objectives: first, to update reference designs and safety cases for the used fuel deep geological repository and transport systems. Secondly, it is to further increase confidence in the safety case and to enhance the scientific understandings of the relevant processes. The research is conducted in-house and in universities with international collaborations and annually reviewed by the Independent Technical Review Group (ITRG).

In the triennial report presenting the next steps the visual representation of APM as a coupled technical and management process has been abandoned, instead it is described as a process aiming for '[C]entralized containment and isolation of used nuclear fuel in a repository deep underground in a suitable rock formation' (NWMO, 2011: 50). There is a clear image of what the deep geological repository will amount to…

> *…a multiple-barrier system designed to safely contain and isolate used nuclear fuel over the long term. It will be constructed at a depth of approximately 500 metres, depending upon the geology of the site, and consist of a network of placement rooms for the used fuel (see diagram on next page). This project requires a dedicated surface area of about 100 hectares (250 acres) for surface buildings and associated facilities. Underground, the repository*

requires a subsurface area in suitable host rock of about 2.5 kilometres by 1.5 kilometres (375 hectares/930 acres). (NWMO, 2011: 51)

An equally vivid picture conveys the expected emplacement process:

> *Used nuclear fuel will be loaded into specially designed and certified containers at the reactor sites and transported to the repository site where it will be repackaged in corrosion-resistant containers for placement in the repository. The containers will be transported underground to one of many placement rooms. The containers will be placed in vertical or horizontal boreholes drilled into the rock and sealed with bentonite clay, a proven effective sealing material. (NWMO, 2011: 51)*

The NWMO has also settled on a notion of retrievability of the waste throughout the phases of implementation up until the decision is taken, together with the host community, to seal and backfill the repository.

Trying to distinguish APM from deep geological disposal the NWMO emphasises the incorporation of learning and knowledge at each step in the phased decision making to ascertain that it will be possible to adjust the programme as needed. Thus the triennial report presents shallow storage as an optional step that…

> *…may be helpful should there be a need to move the used fuel from one or several of the current interim storage facilities before the deep repository is ready. The optional shallow facility, which would be located at the central site to minimize additional transportation of the used fuel, might then be used to safely and securely store this fuel in the interim period. The plan also builds in the potential for the retrieval of the used fuel for an extended period, until such time as a future society makes a determination on the final closure, and the form and duration of post closure monitoring. (NWMO, 2011: 55)*

Simultaneously with initiating the site selection in May 2010 the NWMO launched two programmes to support the process locally. One was called: 'Learn More – Focus on Early Steps' and included five steps to introduce a community to the project and the issues. The other was a 'Research Support Program – Studies in the Humanities and Social Science' which funds research contributing to building understanding of important issues related to the site selection process. There was also a new programme of awareness raising; a mobile exhibition touring the country and a suite of communications materials. A website dedicated to siting was launched.

While the instrumentalisation of the humanities is a creative and innovative move the engineering research of the NWMO closely resembles that of other countries. The spent fuel will be disposed of in the form of CANDU bundles; hence their durability and integrity are subjected to research. The material for the containers in which the used bundles will be disposed of is also a research topic, looking particularly at the corrosion of different materials. In this context the environment in which the containers will be kept is also analysed. Finally, the issue of sealing the repository is to be addressed. The detailed discussion of repository sealing reveals the tension in the NWMO's work, between the culture of engineering in which every step of a project must be clearly defined and signed off before project start and the APM process, anticipating future changes.

9. Concluding remarks

The re-think of geological disposal undertaken by the NWMO created a policy addressing the social unacceptability of the AECL concept identified by the Seaborn Panel. APM emerged as a new combination overcoming the socio-technical challenge that stopped the AECL. At the moment Canada's APM program appears to be well underway, with ten potential host communities remaining in the process the possibility of siting a geological repository looks promising. It seems as if the extensive public engagement process initiated by the first incarnation of the NWMO has been beneficial to the implementation of the program. That the initially unique concept of APM seems to have transmogrified into a more traditional concept of deep geological disposal appears not to have resulted in any perceptible public protest.

A feature of the Canadian program that resembles developments in the UK is the localisation of the issue with the implementation of a voluntary siting process. When the initiative is left to local communities the political deliberation also becomes local, which changes its character. On the one hand it becomes more democratic, it is easy to imagine all residents of a locality such as English River First Nation or Nipigon taking part in deliberations and decision making. On the other hand it is politically defused, when removed from the national agenda it becomes difficult for organised opposition to conduct critical scrutiny. For example, the argument against decoupling waste management from nuclear power generation and uranium mining may appear less salient to the English River First Nation council and chief than it would to the federal parliament members.

Regardless of future developments of APM the process of inventing and embarking on the first step shows the benefits of taking society seriously. The Canadian government's response to the Seaborn Panel of removing the technical organisation from the lead changed the approach. The later mission creep could signify an inability of scientists and engineers set on geological disposal to think differently, indicating that this expert community failed to comprehend the Seaborn Panel's conclusions that any technical concept has to be socially acceptable. The invention of the NWMO enabled a process that took public participation in democratic decision making seriously and whose actions took precedence over technical expertise. While the NWMO was not separated from the nuclear industry it was not made up of technical experts, but comprised very high-ranking people experienced in leadership and negotiation. Even if the incorporation of science and engineering caused mission creep in the reconfigured NWMO the APM established and formalised ways of engaging with the public with the potential to remain robust for the foreseeable future, since they are both statutory and funded. The weaknesses academic critics identify in the social concept are becoming less relevant as the socio-technical process evolves with new relationships forming between actors as they address new challenges arising.

References

Callon, M., Lascoumes, P. & Barthe, Y. (2009) Acting in an uncertain world. An essay on technical democracy (translated by Graham Burchell). Cambridge MA: MIT Press

CNSC (Canadian Nuclear Safety Commission) (2006) Regulatory Guide G–320 Assessing the Long Term Safety of Radioactive Waste Management. Ottawa: CNSC

Durant, D. (2009) 'The trouble with nuclear', in Durant, D. and Johnson, G. F. (eds.) Nuclear waste management in Canada. Critical issues, critical perspectives. Vancouver: UBC Press, 11-30

Durant, D. and Stanley, A. (2009) 'An Official Narrative: Telling the History of Canada's Nuclear Waste Management Policy Making', in Durant, D. and Johnson, G. F. (eds.) Nuclear waste management in Canada. Critical issues, critical perspectives. Vancouver: UBC Press, 31-51

Garamszeghy, M. (2010) Nuclear Fuel Waste Projections in Canada – 2010 Update December 2010. NWMO TR-2010-17. Toronto: NWMO

Golders Associates (2011) Summary report: Initial screening for siting a deep geological repository for Canada's used nuclear fuel. English river first nation, Saskatchewan. Golder Report Number 10-1152-0110 (4000B). Saskatoon: Golders Associates

Jasanoff, S. ed. (2004) States of knowledge: The co-production of science and social order. London: Routledge.

Johnson, G. F. (2009) 'The darker side of deliberative democracy: The Canadian Nuclear Waste Management Organization's national consultation process', in Durant, D. and Johnson, G. F. (eds) Nuclear waste management in Canada. Critical issues, critical perspectives. Vancouver: UBC Press, 90-105.

Latour, B. (2004) The politics of nature: How to bring the sciences into democracy. Cambridge MA: Harvard University Press.

Nuclear Fuel Waste Management and Disposal Concept, 1998, Blair Seaborn Panel Report. Minister of Public Works and Government Services Canada. www.ceaa.gc.ca/default.asp?lang=En&n=431C8844-1, 3/7/2012.

NWMO (2011) Moving forward together: Triennial report 2008-2010. Toronto: NWMO

NWMO (2010) Moving forward together: Annual report 2008. Toronto: NWMO

NWMO (2009) Moving forward together: Annual report 2008. Toronto: NWMO

NWMO (2008) Moving forward together: Annual report 2007. Toronto: NWMO

NWMO (2007) Looking ahead – Planning for the future: Managing Canada's nuclear waste. Annual report 2006. Toronto: NWMO

NWMO (2005a) Choosing a way forward: The future management of Canada's used nuclear fuel. Final study. Toronto: NWMO

NWMO (2005) From dialogue to decision: Managing Canada's nuclear waste. Annual report 2004. Toronto: NWMO

NWMO (2004) From dialogue to decision: Managing Canada's nuclear waste. Annual report 2003. Toronto: NWMO

NWMO (2003) From dialogue to decision: Managing Canada's nuclear waste. Annual report 2002. Toronto: NWMO

Sierra Club (2005) Proceedings, Response and Recommendations: from Roundtable Discussion on Nuclear Waste Management September 15-16, pdf downloaded from www.nwmo.ca, 10/11/2011

Stanley, A. (2009) 'Representing the Knowledges of Aboriginal Peoples: The "Management" of Diversity in Canada's Nuclear Fuel Waste', in Durant, D. and Johnson, G. F. (eds.) Nuclear waste management in Canada. Critical issues, critical perspectives. Vancouver: UBC Press, 106-129

Stanley, A. (2008) 'Citizenship and the production of landscape and knowledge in contemporary Canadian nuclear fuel waste management', The Canadian Geographer 52/1: 64-82

Wilding, E. T. (2012) Framing Ethical Acceptability: A Problem with Nuclear Waste in Canada', Science and Engineering Ethics, 18: 301-313, DOI: 10.1007/s11948-011-9262-6