A Nuclear Renaissance without Disposal?

All countries that use nuclear energy now, or that wish to do so in the future, must have a credible waste disposal strategy that will lead to safe disposal when this becomes necessary. In addition, this strategy must be accepted by a sufficiently large fraction of the population.

By Charles McCombie and Neil Chapman

Nuclear power is undoubtedly experiencing more rapid growth than it has for decades. This "nuclear renaissance" is heartening many experts who joined the industry back in its first heyday, expecting then to see a continuous rapid development of a powerful new technology. It didn't happen as was expected back then. Instead, nuclear energy production stagnated, in particular in the Western world. Three prime problems were responsible for this: public concerns about reactor safety, business doubts about economics, and no clear demonstration of a waste disposal route. What is the situation today? The authors believe that the former two issues have been resolved to the satisfaction of the majority of stakeholders, but that waste disposal could again be a stumbling block to the expansion of nuclear power programs around the world.

Nuclear reactors have proven to be a safe and reliable source of base-load electricity. The few major accidents that have occurred resulted in large financial losses but relatively few fatalities. Although financing mechanisms can still be problematic (in particular in the United States), the life-cycle costs of nuclear electricity now look very favorable compared to the alternatives. A major reason for this is the vastly improved efficiency and increased availability of nuclear power plants. Another key reason is that—finally—fossil fuel competitors are being forced to meet costs required to check atmospheric pollution and CO_2 emissions. In the eyes of much of the public, however, "the waste problem" is still unsolved. Specifically, the final disposal of radioactive wastes remains a controversial public and political issue.

Of course, there has been tremendous progress made toward safe geological disposal of high-level waste or spent fuel. The necessary technologies have been developed. In some countries—e.g., Finland and Sweden—preferred repository sites have been selected. Nowhere, however, is disposal in progress—and this will remain the case for 10 years or more, as illustrated in the accompanying table.

Planned Operational Dates for Geological Repositories

Country: Date	Country: Date
Austria: no plans	Lithuania: no plans
Belgium: after 2025	Netherlands: after 2100
Canada: open	Romania 2049
China: after 2040	Slovakia: 2037
Czech Republic: 2065	Slovenia: 2066
Finland: 2020	Spain: 2035
France: 2025	South Korea: open
Germany: 2030	Sweden: 2020
Hungary: 2047	Switzerland: 2040
Italy: no plans	United Kingdom: open
Japan: 2035	USA: open

What does a credible waste disposal strategy require? The components are the availability of the necessary technologies, personnel, and funding—and, importantly, a siting strategy that that can deliver *at the required time* an acceptable location for a repository.

The situation is somewhat better now than in the early rise of nuclear. Geological disposal is widely accepted as the correct way forward, and the technical community has reached consensus on the feasibility of constructing, operating, and closing safe and secure repositories. But public and political skepticism remains strong.

Is it responsible, or indeed feasible, to accelerate the expansion of nuclear energy without sufficient acceptance of disposal? Are we heading into the same problem that hindered nuclear the first time around, giving rise to the criticism that constructing a nuclear power plant without a repository was like "building a house without a toilet?" How will this nuclear renaissance affect the effort being put into repository development?

The negative scenario is that the urgent need for more energy will far outweigh the postponable task of repository implementation, which will then again be neglected. Already some signs of this are visible. The United States argued not so long ago that operation of the Yucca Mountain repository was a prerequisite for new nuclear plants in the country. Today, however, license applications are being submitted despite the very uncertain future of that repository project. Other developed countries with existing nuclear plants, such as the United Kingdom, China, Taiwan, Russia, and Canada, are contemplating new nuclear build, although no repository is in sight. The hunger for electrical energy in numerous less-developed countries that are now considering nuclear power (e.g., the United Arab Emirates, Jordan, Indonesia, Vietnam, Algeria, Thailand, Turkey, and Nigeria) is attracting potential nuclear vendors who offer to provide reactors and fuel services but no disposal route.

The solution to the problem is not to insist that repositories actually be available before new nuclear plants begin to operate. This would not, in any case, be feasible in practice, given the long repository development times. It is also not necessary, because an HLW or spent fuel inventory for disposal will not arise from any new nuclear plant for decades because of the long cooling times and the slow accumulation of waste inventories. The crucial task is to ensure that all countries that use nuclear energy now, or wish to do so in the future, have a *credible waste disposal strategy* that will lead to safe disposal when this becomes necessary and that this strategy be accepted by a sufficiently large fraction of the population. This task was not successfully accomplished in the early days of nuclear power, and the result was that opponents had a powerful argument to brake or halt nuclear developments. There is a real danger of the same thing happening again in the near future. The apt saying, often attributed to Benjamin Franklin or Albert Einstein, is that "the definition of insanity is doing the same thing over and over and expecting different results." By again underestimating the importance of the back end in nuclear power development plans, we may well be proving ourselves insane!

What does a credible waste disposal strategy require? The components are the availability of the necessary technologies, personnel, and funding—and, importantly, a siting strategy that that can deliver *at the required time* an acceptable location for a repository. Large national nuclear programs with no such strategy must work on all three components. Countries like the United Kingdom and Canada, having recently reestablished a consensus on geological disposal as such, are initiating appropriate siting programs for geological repositories. In some other nuclear countries planning or contemplating new build, however, little attention appears to be devoted to the repository program. Among the countries seeking to introduce nuclear, almost none seems to address the waste disposal program at the outset.

This is regrettable, because the personnel and financial resources required in the early stage of a nuclear waste management program are modest. A prudent approach for new nuclear countries would be to recognize the technological and financial implications and to start out on the siting task in a "dual-track" manner. By this we mean an approach that includes (a) a national survey of geologically, environmentally, and socially acceptable disposal concepts and siting options and also (b) linking up with potential partner countries to investigate multinational approaches that could provide safe and economic disposal options.

The latter option might be achieved by partnering with other small or new nuclear countries or else by negotiating export of spent fuel or HLW (and other long-lived wastes) to a third country.

The Nuclear Renaissance Is Real

There are currently 439 nuclear power plants in operation in 30 countries. (This information is largely based on March 2009 data from www.world-nuclear.org.) These reactors supply about 15 percent of the global electrical energy con-

sumed today. In the Western world, nuclear programs have been stagnant or decreasing for two decades, although construction of new plants continued in some parts of the world such as East Asia. A resurgence of nuclear power has been predicted at various times in the past, but the current increase in activity and interest appears, more than anytime as yet, to herald a real renaissance. The drivers are energy security, fossil energy costs, and concerns about carbon dioxide contributions to climate change.

Countries with operating nuclear plants are seeking to replace old reactors as well as expand capacity, countries that have shut down plants or have planned to do so are rethinking those decisions, and many countries are considering or firmly planning to make nuclear energy part of their national power supply. All parts of the world are involved in this development. The following sections give a summary of the declared intentions—although the current financial crisis implies that some of the more ambitious plans may need to be taken with a pinch of salt.

Expansion of Established Nuclear Programs

Most of the recent expansion has been centered in the Eastern half of the world. The Chinese government plans to increase nuclear generating capacity to 40 GWe by 2020. Currently China operates 11 reactors, has 6 under construction and intends to start on 10 more by 2010. India's target is to construct 20 to 30 new reactors by 2020 as part of its national energy policy; 6 are currently under construction. Pakistan is expanding its nuclear fleet with Chinese-designed reactors, and its 2005 Energy Security Plan includes construction of an additional 8 GWe of nuclear capacity by 2030. Russia has 6 reactors under construction and 17 in the planning stage, aiming to increase its nuclear capacity to 50 GWe by 2020. Japan has two reactors under construction and plans or placed orders for 11 new nuclear power plants; it is also involved in intense research on future reactor designs. The Republic of Korea already has 20 operating power reactors supplying about 40 percent of electricity demand, 1 nuclear plant under construction, and 7 more planned.

The expansion of existing nuclear power programs is not, however, limited to Asia. In Europe, Finland and France are both building new evolutionary power reactor plants from Areva. The U.K. government has endorsed the replacement of the country's aging nuclear reactors with new nuclear build. Several countries in Eastern Europe are currently constructing new plants (Romania) or have firm plans to build new nuclear power plants (Bulgaria, Czech Republic, Romania, Slovakia, Slovenia, and Turkey). Sweden has abandoned its plans to prematurely decommission its nuclear power reactors and is now investing heavily in life extensions and in uprating its existing plants. Hungary, Slovakia, Switzerland, and Spain are all planning for life extensions on existing plants and/or considering new plants. Italy is considering a revival of its scrapped nuclear program and has already invested in reactors in Slovakia.

Nuclear power countries in the Western Hemisphere are also seeking to expand their programs. In the United States, notices of application for joint construction and operating licenses have been submitted for more than 20 new units, and it is clear that there will be substantial new nuclear capacity by 2020. In Canada, the Ontario government has decided to refurbish and restart four reactors, thus adding 25 years to their operating lifetimes, as a step in its plan to expand its nuclear fleet. Two more reactors will be needed for Ontario under its mid-2006 policy. Alberta is now considering using nuclear power to extract oil from its northern deposits of oil sands. Argentina and Brazil both have commercial nuclear reactors generating electricity, and additional reactors are planned or under construction. Chile has a research reactor in operation and has the infrastructure and intention to build commercial reactors.

Finally, in the only country in Africa that currently has nuclear power, South Africa, there are plans to import further light water reactors and to construct a demonstration pebble bed modular reactor and then a fleet of these plants.

New Nuclear Programs

South Africa may be joined as a nuclear power nation by other African countries that are currently showing interest in introducing new, clean base-load energy. Nigeria has sought the support of the International Atomic Energy Agency (IAEA) to develop plans for two 1000-MWe reac-

A RESURGENCE OF NUCLEAR POWER HAS BEEN PREDICTED AT VARIOUS TIMES IN THE PAST, BUT THE CURRENT INCREASE IN ACTIVITY AND INTEREST APPEARS, MORE THAN ANYTIME AS YET, TO HERALD A REAL RENAISSANCE. THE DRIVERS ARE ENERGY SECURITY, FOSSIL ENERGY COSTS, AND CONCERNS ABOUT CARBON DIOXIDE CONTRIBUTIONS TO CLIMATE CHANGE.

tors, and Egypt has revived its plans for a combined nuclear power and desalination plant. Morocco and Algeria are additional African countries considering nuclear energy.

Entry into nuclear energy production is being considered also by several other nations in the world. In Europe, these include Poland, Estonia, and Latvia, which are looking into a joint project with established nuclear power producer Lithuania. The United Arab Emirates, Jordan, and Turkey are seriously considering or planning for the introduction of nuclear power programs. In the East, Vietnam has plans to build up to eight nuclear reactors by 2025. Indonesia plans to build two 1000-MWe reactors in central Java. Thailand has announced plans to build two large nuclear plants, with construction to begin in 2015. Bangladesh signed an agreement with China in 2005 regarding nuclear cooperation and plans for nuclear power. In Malaysia, a comprehensive energy policy study—including consideration of nuclear power—is to be completed by 2010.

Implications for National Disposal Programs

The growth in existing nuclear programs and the spread of nuclear technology to new countries will have a serious effect on the back end of the fuel cycle because of the increased concerns about proliferation and about waste management. The effort expended on planning and implementing waste management strategies—especially for waste disposal—may increase or decrease over the coming years. An increase in intensity and in the resources devoted to waste management will result if the proof of a viable disposal option is a prerequisite for new build of power stations. Given the variety of new nuclear power plant designs that are being pushed on the market, more attention might be focused on waste issues if these directly influence choice of reactor vendor.

On the other hand, it is also conceivable that the "rush to nuclear" will reduce interest in waste issues. These may be judged less urgent when compared with the higher priority goals of increasing dependable energy supplies or of reducing CO_2 emissions. A recent fuel-cycle issue that can also affect the amount of effort devoted specifically to disposal of spent fuel is the revival of interest in recycling. If nuclear power is to be sustainable or at least usable for hundreds of years rather than as a transition energy source, then it becomes imperative to recover the useful materials in the spent fuel. This may increase the attraction of long-term storage rather than moving to disposal of spent fuel (or else may favor repository concepts that ease retrieval). Finally, at a more mundane level, the recognized shortage of nuclear specialists in general may mean that there are too few who wish to work in the waste area, rather than in the more exciting tasks of building and operating power plants.

It will be a serious risk, however, if the expected future rapid increase in nuclear power is attempted without proper regard for the waste issues—as was the case during the initial buildup of nuclear in the 1960s and 1970s. Attempts to initiate new nuclear power plant programs without a back-end strategy will open nuclear to criticism and will intensify disposal-based opposition by environmental groups. The so-called "waste problem" must be recognized by society as being solved or at least solvable. The biggest challenge facing a geological disposal program is repository siting.

Siting a National Geological Repository

Successful *national* repository siting is dependent on achieving, at the outset, a sufficiently broad consensus among stakeholders on the following premises:

- A safe solution for the long-term management of long-lived radioactive wastes is required by all parties. The parties referred to in the national case are communities, regions, or political jurisdictions.
- Geological disposal in a deep repository is the only available approach today that can guarantee the required

If nuclear power is to be sustainable or at least usable for hundreds of years rather than as a transition energy source, then it becomes imperative to recover the useful materials in the spent fuel. This may increase the attraction of long-term storage rather than moving to disposal of spent fuel (or else may favor repository concepts that ease retrieval).

level of safety—provided the repository is properly implemented at a well-chosen site.

- Numerous small repositories in a country are, for reasons of cost, safety, and security, either unfeasible or, at a minimum, clearly less effective than fewer or even a single shared facility. At present, even the largest national disposal programs are seeking only a single site for implementation of a geological repository.
- A repository host community is providing a localized service to a wide range of users. Hosting such a shared facility can result not only in real or perceived drawbacks for the host party but also in specific benefits, such as financial gains, broader economic developments, or increased political leverage.
- If these benefits are judged to outweigh potential drawbacks, willing hosts may well come forward. In any case, a repository will not be imposed on any party against its will.

Assuming that the involved parties accept all of these premises, consensual siting is feasible.

However, a transparent process leading to identification of technically or socially acceptable sites is still required. Much progress toward identifying a generically suitable process has been made by national waste management programs in recent years, although the way it is being implemented today differs in detail from country to country. The generic characteristics of a suitable siting process are broadly agreed to be as follows:

- It is adaptively staged and acknowledged to be a multiyear process that will evolve as the implementers take account of feedback from all stakeholders.
- The siting process is based on objective, transparent, predefined, and well-documented criteria.
- The objective is to identify sites that are demonstrably safe, and the process is not based on claims that a "safest" site can be identified.
- The process includes true dialogue between all stakeholders, especially potential hosts, with the objective of ensuring that it is regarded as fair and equitable by all.
- The aim is to identify informed and willing repository hosts that will subsequently be full partners in the repository implementation process and therefore have a direct influence on the project development.

Increasingly, national programs are accepting that potential siting communities must be directly involved in the siting process and finally must be willing hosts. Japan is looking for voluntary sites. The Swedish implementer, SKB, agreed to accept any local veto despite legislation that would allow the government to overrule this. Both the United Kingdom and Canada have recently chosen strategies based on consensual siting. Successes are also being registered in national disposal programs that seek local community assent. In both Finland and Sweden, competition has even arisen between potential sites.

Implications for Multinational Disposal Initiatives

The growth in interest in nuclear power in countries that have as yet only small nuclear energy programs or that have no nuclear plants will also affect the prospects for multinational disposal or disposal proposals. The potential impacts can be considered under three headings, each related to a recognized benefit of shared nuclear facilities: (a) economics, (b) safety and security, and (c) political/public support.

The high cost of repositories means that new or small nuclear power plant programs will not be able to afford a national repository and must be interested in prospects for cost sharing. It may even be that there are so many small nuclear countries looking for a disposal route that there is a market for competing multinational repositories. On the other hand, some currently small programs may grow large enough to make national disposal a feasible strategy—particularly if repository implementation is in the far future. The economics of the back end may also be directly connected with front-end costs if competition to supply reactor fuel or uranium leads to offers of leasing either of those as a sales argument. A final point related to economics is that increased use of nuclear energy may result in spent fuel inventories that grow quickly enough to make new interim storage facilities necessary, so that the financial benefits of pooling facilities may be reexamined.

International concerns about safety and security have already led to pressure to concentrate nuclear materials at fewer, well-controlled locations. The list of potential new nuclear countries given earlier in this article makes it obvious that pressures of this sort may well increase. This can lead to more support for facilities shared by smaller countries or else to growth in importance of the "add-on scenarios," as defined by the IAEA—i.e., scenarios in which large nuclear programs accept wastes for disposal from smaller ones. Proposals of this sort have been made in the U.S. Global Nuclear Energy Partnership (GNEP) and the Russian Global Nuclear Power Infrastructure (GNPI) projects. In any case, the spread of nuclear power will certainly result in increased international control of multinational initiatives. It may even increase the possibility of "supranational scenarios" in which a direct, operational role in waste storage and disposal is taken by the IAEA and the European Community (EC).

In the area of nuclear security, there is again a danger that governments and the industry will neglect the back end relative to more critical risk areas such as nuclear power plant operations, uranium enrichment, and fuel reprocessing. In the back end itself, there is also a danger that proliferation concerns will lead to neglect of HLW and intermediate-level waste issues relative to spent fuel, although disposal plans for all long-lived wastes should be moved ahead simultaneously.

For multinational storage or disposal initiatives, as for national programs, the biggest challenge today is winning sufficient political and public support for siting facilities. In the multinational case, the political aspects loom large, but there are significant developments.

Increased support at the international level (the IAEA and the EC) is to be expected—primarily for the safety and security reasons mentioned earlier. For small or new programs, increased support for multinational strategies may result if the waste issue is judged crucial; a decrease in interest and support may occur if the waste issue is postponed for decades. In the past, large established waste disposal programs have often expressed concerns that despite legislation or policies forbidding waste import, multinational initiatives could harm public acceptance of their national waste disposal programs. It is difficult to judge whether these concerns will increase or decrease as

The ideal approach is that potential host sites result from voluntary expressions of interest at the local community level. However, the national government of the potential host country would obviously, at a minimum, have to agree not to block or forbid such local community volunteering.

more countries turn to nuclear. Large programs may feel under increased pressure to provide add-on solutions requiring them to accept wastes from other countries—and nuclear opposition groups will certainly use such arguments. The GNEP proposals have already led to debate of this sort in the United States and in Canada. On the other hand, the many countries aiming to become nuclear energy users could lead to an increase in the numbers of those willing to actively pursue the option of shared disposal. This could lead to new, formalized multinational or regional groupings being founded. The existence of such groups would serve as evidence that new nuclear nations are acting responsibly to develop waste disposal solutions based on siting only in willing and capable host countries.

Siting in the Multinational Case

Initiatives aimed at developing regional, multinational waste disposal facilities have been criticized as not being credible until such time as a country agrees to host one. Are such initiatives really "castles in the air"—unrealistic fantasies with no identified location and hence with no hope of being implemented?

An obvious counter to such criticism is that if lack of an agreed site implies that a radioactive waste disposal program will fail, then there are remarkably few successes in the national disposal programs around the world today. Only in Finland has a preferred site for deep disposal been agreed to at all necessary regulatory and legal levels. A few other countries are quite close to this stage (e.g., Sweden and France), but they have not yet cleared the final hurdles. Furthermore, all these programs, including the Finnish success, have spent decades in the siting process.

On this basis, it seems premature to write off budding programs to develop multinational repositories as unrealistic because they have not identified a host country in the first years. In practice, multinational strategies can be modeled directly on successful national siting approaches in that they have to go through exactly the same technical and stakeholder involvements steps, may take many years to achieve siting successfully, and, in fact, should actually avoid premature selection of potential sites. The elements of national approaches that can guide multinational strategies were summarized earlier.

What are the differences between this idealized national repository siting process and a multinational process? Almost none. When the parties interested in jointly using a shared repository are sovereign nations rather than subnational entities, the hurdles to be surmounted are basically the same—although some of them are undoubtedly set higher. Furthermore, some siting options at the national level, such as imposing a facility on a community if no volunteers came forward, are not feasible in a multinational process. This "last resort" option has arguably played a role in some national repository programs. The U.S. Congress overrode the state of Nevada's veto on the selection of Yucca Mountain. The Swiss government, after a cantonal referendum led to the loss of a potential site at Wellenberg, changed the law so as to remove cantonal veto rights. In Germany, the AkEnd government advisory group was divided on whether a government ruling could unilaterally fix a site in the event that no willing communities came forward.

As pointed out earlier, however, national programs are increasingly accepting the fact that potential siting communities must be willing hosts. In such an environment, willing national hosts in a multinational initiative appear no less likely than local hosts for a national facility. A further hopeful indication that optimization of waste management can occur above the national level is provided by current hazardous waste disposal projects. In Europe, several nations export and import hazardous chemical wastes without raising public concern, in order to make use of the best available facilities.

A staged approach for a multinational facility needs to tackle some difficult and high-profile matters up front. It need not solve them all at the outset, but it must have a transparent, agreed route to doing so. Specifically, the approach should be clear about the extent of commitment being made by partner countries on joining a shared solution enterprise and at all subsequent siting stages. In this respect, we can consider the following points:

- The ideal approach is that potential host sites result from voluntary expressions of interest at the local community level. However, the national government of the potential host country would obviously, at a minimum, have to agree not to block or forbid such local community volunteering.
- The mechanisms and implications of being in or out of

the pool of potential host countries need to be established by the partners at the start of the project. One approach to starting the siting work would be to establish agreed exclusion criteria for clearly unsuitable land and then to invite volunteers in the nonexcluded land areas of partner countries.

- Partners could enter the project at different stages. Only when the largest programs likely to be in the eventual project are known with more confidence can a sensible estimate be made of the costs of repository implementation and of the scale of benefits and impacts to the host country and community.
- Partner countries that already have developed national siting programs will be readily able to pool their knowledge, but they will also have to decide how to deal with sites and communities that are already being considered as possible national repository locations.

Potential Global Siting Regions for Multinational Repositories

Where might regional or multinational repositories first be implemented? Currently, the most intensive work on this concept has been done within the SAPIERR (Support Action on a Pilot Initiative for European Regional Repositories) project, which concentrated on the feasibility of establishing one or more regional repositories serving several European countries. This project, which has now completed its second phase, was funded by the EC, reflecting the support for such an approach as expressed in the European Parliament. The following were the goals of SAPIERR:

- To develop an organizational framework and a project plan to facilitate debate on the establishment of a modestly sized, self-sufficient European repository development organization that can work in parallel with national waste agencies.
- To perform further studies on key issues related to economics, design, public and political attitudes, and the safety and security of shared storage and disposal facilities.
- To achieve and document the consensus of interested parties from a number of nations on a preferred way forward.

The ultimate objective of SAPIERR was to propose a practical implementation strategy and organizational structures that will enable a group of countries to create a formalized, structured organization that could be established for working on shared European Union (EU) radioactive waste storage and disposal activities. Because the SAPIERR results published at the end of 2008 were endorsed by a sufficient number of European countries, an ad-hoc multinational group is being set up to agree on a framework for a formal implementing body for a regional repository. The structure, size, domicile, and program of this European Repository Development Organization (ERDO) should be defined by a multinational working group meeting over the next one to two years.

The concept being developed is, however, also applicable in other regions of the world where small nuclear programs exist or new nuclear programs are being proposed. For example, further bodies could be established in the following global regions:

- Asia: Taiwan and Korea have had considerable problems in siting national disposal facilities, even for low-level waste. Both also have challenging geological environments and would be clear candidates for partnering, despite their substantial nuclear programs. More obvious participants would be the countries in the region now considering initiating nuclear programs.
- Arab States: The Gulf States have already established a cooperative effort to introduce nuclear power. Jordan has also expressed the wish to do so and has supported regional disposal concepts. Other Arab countries such as Algeria and Egypt are possible candidates.
- Central/South America: Mexico needs a disposal solution, as do Brazil, Argentina, and, depending on the course of decisions on future nuclear power programs, Chile and Peru.
- Africa: South Africa has great nuclear ambitions and also large areas where safe geological repositories could be implemented. They currently follow a purely national strategy, rather than offering disposal services to their continental neighbors. In this case, other African countries, such as Ghana, Nigeria, or Namibia, that are contemplating introducing nuclear power would need access to another repository, possibly implemented in a regional framework.

A VERY IMPORTANT POINT TO NOTE IS THAT IT IS NOT ONLY THOSE COUNTRIES THAT HAVE, OR WILL HAVE, NUCLEAR POWER PLANTS THAT REQUIRE ACCESS TO A GEOLOGICAL REPOSITORY. OTHER NUCLEAR TECHNOLOGY APPLICATIONS ALSO PRODUCE LONG-LIVED WASTES THAT SHOULD BE DISPOSED OF IN THIS WAY. THE QUANTITIES ARE MODEST, BUT THE HAZARD POTENTIAL IS NOT.

The strong focus of proposals on front-end issues like security of fuel supply ignores the facts that the free market in fuel has always ensured an adequate supply and that the key service that really should be offered is waste disposal.

A very important point to note is that it is not only those countries that have, or will have, nuclear power plants that require access to a geological repository. Other nuclear technology applications also produce long-lived wastes that should be disposed of in this way. The quantities are modest, but the hazard potential is not. Regional repositories offering a safe disposal service would therefore also contribute to environmental health and safety in such nonnuclear power nations. The ERDO Working Group mentioned previously will include representatives from countries such as Austria and Ireland, neither of which has any interest in deploying nuclear power.

Alternatives to Partnering

Are there realistic alternatives to regional repositories shared by partner countries, if global safety and security is the objective? The scenario in which every country, however small, implements its own state-of-the art geological repository is scarcely credible. Lack of resources and technical capabilities effectively rule this out. The partnering approach has been the focus of Arius work for some years and is best exemplified at present by the EU's SAPIERR project. The currently most likely scenario for the export of spent fuel involves "take back" of leased fuel by a large supplier. This option is part of the United States' GNEP proposal and Russia's GNPI proposal—both of which are facing major opposition in their home countries.

Unfortunately, neither of these take-back offers is committing in its readiness to retain the HLW that would result from their reprocessing of the fuel—and therefore they would not relieve a new nuclear country of the need to establish a small but very expensive geological repository. Gaps will remain unless fuel-leasing countries also accept the backlog of spent fuel that exists in some potential user countries, vitrified HLW resulting from reprocessing, and also other long-lived wastes. The probability of such a wide service being offered may well be far lower than that of small nuclear waste producers getting together on their own terms, as partners to implement shared regional repositories.

Importantly, the strong focus of such proposals on front-end issues like security of fuel supply ignores the facts that the free market in fuel has always ensured an adequate supply and that the key service that really should be offered is waste disposal. Analogous to the powerful, simple but focused slogan that helped the election of President Clinton, the mantra here might be, "It's the waste, stupid!"

Positive Impulses Must Dominate

A renaissance has been prophesized by the nuclear industry at various times over the past 20 or more years—with no visible consequences. However, the current surge of interest in expanding or initiating nuclear programs appears more concrete than on any previous occasion. Avoiding energy shortages, reducing future energy costs, and mitigating global climate change are all powerful arguments. The resurgence of nuclear can have positive or negative effects on the global efforts devoted to implementing safe and acceptable waste management strategies. It is imperative that the positive impulses dominate if the nuclear renaissance is to succeed. In its original period of expansion, the nuclear industry paid too little attention to waste disposal, working under the understandable assumption that ample time remained for developing solutions. This led to waste management becoming identified by the public as the Achilles heel of nuclear power.

From a technical point of view, the most urgent tasks in rapidly expanding nuclear power are again not waste specific. They are related to (re)building engineering capacities, ensuring supplies of large components, accelerating licensing processes, educating personnel, etc. But the industry cannot afford to ignore nontechnical aspects and decide again that waste can wait. ■

Charles McCombie is executive director of the Arius Association and a principal with MCM Consulting. Neil Chapman is chairman of the ITC School of Underground Waste Storage and Disposal, research professor at the University of Sheffield, program director for the Arius Association, and a principal in MCM Consulting. For additional information, contact Charles McCombie at charles.mccombie@mccombie.ch.

This article is adapted from a paper presented at the American Nuclear Society's 12th International High-Level Radioactive Waste Management Conference, held September 7–11, 2008, in Las Vegas, Nev.