

**Birds of a Feather ...**  
**Developments towards shared, regional geological disposal in the EU?**

Hans D.K. Codée, Ewoud V. Verhoef  
COVRA N.V.  
P.O. Box 202, 4380 AE Vlissingen, The Netherlands  
Charles McCombie,  
Arius, P.O. Box 5250, 5405 Baden Switzerland

**ABSTRACT**

Geological disposal is an essential component of the long-term management of spent fuel, high-level and other long-lived radioactive waste. In the EU, all 25 member states generate radioactive waste. Of course, there are large differences in type and quantity between the member states, but all of them need a long-term solution. Even a country with only lightning rods with radium will need a long-term solution for the disposal. The 1600 year half-life of radium does not fit in a solution with a span of control of just a few hundred years. Implementation of a suitable deep repository may, however, be difficult or impossible for countries with small volumes of waste, because of the high costs involved.

Will economy of scale force these birds of a feather to wait to flock together and share a repository? Implementing a small repository and operating it for very long times is very costly. There are past and current examples of countries being prepared to accept radioactive waste from others if a better environmental solution is thus achieved and if the arrangements are fair for all parties involved. The need for supranational surveillance also points to shared solutions. Although the European Parliament and the Commission have both supported the concept of shared regional repositories in Europe, (national) political and societal constraints have hampered the realization of such facilities up to now.

The first step in this staged process was the EC funded project, SAPIERR I. The project (2003 to 2005) studied the feasibility of shared regional storage facilities and geological repositories, for use by European countries. It showed that, if shared regional repositories are to be implemented even some decades ahead, efforts must already be increased now. The next step in the process is to develop a practical implementation strategy and organizational structures to work on shared EU radioactive waste storage and disposal activities. This is addressed in the EC funded project SAPIERR II (2006-2008). The paper gives an update of the SAPIERR II project and describes the progress achieved.

**INTRODUCTION**

It has been increasingly acknowledged over the past years that regional or multinational repositories can potentially improve the safety, security and economics of radioactive waste disposal. Although there are sound environmental, safety and security reasons for disposing the radioactive waste in national geological repositories as soon as possible, there are also good reasons why this will not take place in all countries.

For countries with small nuclear power programs, economies of scale will force them either to implement long-term storage and wait for decades, or to share a repository with others. Implementing a small repository and operating it for very long times is very costly. The need for supranational surveillance also points to shared solutions and there are past and current examples of countries being prepared to accept radioactive waste from others if a better environmental solution is thus achieved. Although the European Parliament and the Commission have both supported the concept of shared regional repositories in Europe, (national) political and societal constraints have hampered the realisation of such facilities up to now.

If storage and disposal facilities for radioactive wastes are to be shared, a long, phased or staged process has most chance of success, as demonstrated by the most successful national projects. Such a process should not conflict with any national programme goals or prematurely commit the participants to a shared repository. In this way, small nuclear programmes will have an alternative approach that can, if desired, be run in parallel with national activities. Larger nuclear programmes that have decided on a purely national disposal programme can make their expertise available to regional repository initiatives. They can also point out to their local populations that other Member States are seeking independent shared solutions, so that compulsory import of wastes is not a threat to any national programme. This paper describes the first two steps of such a staged process.

## **SAPIERR I**

In the period 2003 to 2005, the EC funded project, SAPIERR I (Support Action on a Pilot Initiative for European Regional Repositories), was devoted to pilot studies on the feasibility of shared regional storage facilities and geological repositories, for use by European countries. SAPIERR I was designed to help the European Commission clarify basic questions affecting the issue and to identify new research and technical developments that may be needed to implement regional solutions to European radioactive waste disposal. The official coordinator of SAPIERR I was DECOM Slovakia.

Twenty-one organisations from fourteen countries took part in the SAPIER I project, which addressed legal aspects, inventory questions and possible options and scenarios for regional disposal. The main activities within the project were:

1. reviewing the international and national legal or regulatory issues that would affect implementation of regional storage facilities or repositories
2. constructing a reference inventory of the radioactive wastes arising in all of the 14 countries from which organisations joined the SAPIERR working group

3. evaluating potential designs, implementation timescales and likely costs for shared regional repositories, based on existing documented data on European national programmes
4. looking at potential scenarios for organising the implementation of European regional repositories

### **Legal aspects**

The implementation of a regional repository would almost certainly necessitate changes in a number of national legal systems [1]. The various national attitudes towards shared disposal concepts are often reflected in the policies and in the legal / regulatory framework of the countries. Many countries currently ban import of wastes for disposal (e.g. Austria, Croatia, Czech Republic, Finland, France, Hungary, Latvia, Lithuania). Very few legally ban export; Finland is an exception. A few explicitly acknowledge the possibility of import or export and some have no formal position. A few countries (e.g. Switzerland) have already formulated rather detailed conditions under which import or export of wastes might be permissible.

At an international level, organisations such as the EC and the IAEA, have officially given support to the concept of regional or multinational repositories. Reservations or opposition have been expressed by some major programmes seeking a national solution. It seems clear that more international support for shared disposal facilities could help build acceptance for the concept. The EC and IAEA could help by making more specific the necessary legal and contractual frameworks.

Issues of liability, control, inspection, finances, etc. can be regulated in bilateral or multinational contracts. It would be, however, very sensible if such contracts or treaties were to be concluded with support and guidance from an international body such as the EC of the EU.

### **Economical aspects**

In the SAPIERR I project, various international cost estimates that have been published for spent fuel have been compared. The costs of geological disposal are high (80,000 to 1,200,000 €/ton of spent fuel) and only partially dependent on the amount of waste disposed of. Because of this, geological disposal is disproportionately expensive, sometimes even impossible, for countries with small nuclear power programmes or with only nuclear activities other than power production. In those countries the volume of waste is too small to justify or finance a national repository. Long-term storage to accumulate enough waste and financial resources or sharing repositories with other countries are the only alternatives. Figure 1 shows the economic benefits of shared, multi-national repositories.

Figure 1: Deep repository costs as a function of quantity (spent fuel only)

Even for countries with larger nuclear programmes, co-operation and sharing could be attractive. A shared repository not only pools technical and financial resources, but also provides a wider choice of suitable geological formations and guarantees international supervision.

### **Inventory, concepts and timing**

In order to evaluate potential designs, implementation timescales and likely costs for shared regional repositories certain simplifying (although rather unrealistic) assumptions were made for the pilot study:

- No new nuclear power reactors will be built in the SAPIERR countries.
- The existing ones will operate to the end of their operational lifetimes and will be decommissioned immediately afterwards.
- There will be no plant life extension at the operating reactors.

Based on these assumptions, the combined inventory of spent nuclear fuel (SNF), high-level radioactive waste (HLW), and long-lived intermediate-level radioactive waste (ILW) from all the SAPIERR countries can be estimated [2]. Assuming that three standard sized containers would be used, the number of spent fuel containers could be estimated at approx. 13.000 (see fig. 2). This is a relatively large repository (c.f. Sweden: ~6000 containers; Finland ~1500 containers), although smaller than that which will be needed by large nuclear programmes such as that in France or the USA. Similarly, standardized packages for HLW and partially also for ILW were assumed in order to analyze options for co-disposal in a single repository or for separate repositories for SNF/HLW and ILW.

Figure 2: Production of spent fuel in SAPIERR countries, when spent fuel is packaged after 50 year storage

It was decided to use mature repository design concepts, one for hard rock and one for sediment, that represent the main trends in European repository development at present, and to focus on horizontal emplacement. The latter was chosen for ease of emplacement of SNF packages.

Figure 2 shows the optimum time for a regional repository would be around 2035; this would avoid the need for large SNF buffer storage facility. Calculating back from this time - allowing 5 years to gain operational experience and handle the small backlog of cooled spent fuel (~300 packages) then available - an encapsulation facility should be commissioned in 2030. Allowing 20 – 25 years for siting and site investigation, the development of a regional repository should start around 2010 – 2015. This means that assessing how to set legal and organisational structures for the development process in place should start about now. This is the main objective of the follow-up study, SAPIERR II.

## **SAPIERR II**

SAPIERR II (Strategic Action Plan for Implementation of European Regional Repositories) builds on the pilot studies of SAPIERR I to develop options for organisational frameworks and project plans that could lead to the establishment of an EDO: a European Development Organisation for European regional repositories. To clarify issues related to the structure and future programme of the potential EDO, a series of specific studies are being carried out on organisational structures, legal liabilities, economics, safety and security and public and political acceptability. The options distilled from these studies will be presented and discussed at a workshop for interested countries and organisations, in order to identify potential end-users and to achieve consensus on a preferred way forward: the first steps of implementation or a further programme of preparatory work.

The formal partners in the SAPIERR II project are ARAO of Slovenia, Arius of Switzerland, COVRA of the Netherlands, Decom of Slovakia, ENEA of Italy, Enviros of Spain, RATA of Lithuania and SAM of the UK. Organisations from further European countries have been invited to participate in an associated working group. Through its partners and the invited organisations, the project has access to national data and also to experienced European expert organisations. The official coordinator of SAPIERR II is COVRA, with the technical management being shared by Arius.

### Activities

The work plan is designed so as to fulfil the principal objectives. The first of these, proposing potential structures and project plans for a EDO, requires input from a number of specific studies that together form the second prime objective. The final objective, achieving sufficient consensus on a preferred way forward, should be achieved through interactions and a closing workshop together with bilateral discussions with potential participants in an EDO.

The tasks proposed in the projects are listed and described below. Each task translates into a work package (WP) within the work plan:

1. Preparation of a management study on the **legal and business options** for establishing a EDO leading to one or more proposed frameworks (options) for such an organisation. Possibilities include a Joint Undertaking, a Joint Venture, a Consortium, a dedicated Company, an Association, etc.
2. A study on the **legal liability issues** of international waste transfer within Europe. Even in national disposal programmes, the issues associated with long-term transfer of liabilities are complex. For a regional repository, the challenges are still greater. Immediate transfer of all liabilities and shared responsibilities reaching out to far future times are two extremes that bracket the possibilities to be considered. This issue is important not only for the sharing scenario being pursued by the SAPIERR project, but also outside the immediate scope of the project, should the alternative "add-on" scenario (in which a large nuclear programme inside or outside the EU agrees to accept wastes from other countries) also become relevant. In the latter case, elucidation of liability issues will also be of value to the EU.
3. A study of the potential **economic implications** of European regional storage facilities and repositories. The study is analysing the economic implications for potential users of such facilities and also for host countries. This involves analysing existing costing studies, considering the possible schemes for financial and other compensation measures for a host country and proposing possible financing mechanisms that equitably share the costs of all development work between the interested parties.

Figure 3: Schematic overview of SAPIERR work plan

4. Outline examination of the **safety and security impacts** of implementing one or two regional stores or repositories relative to a large number of national facilities. The radiological safety comparisons will be based on existing performance assessments. The considerations should cover operational safety, long-term safety and also transport. The examination of security

considerations will involve initial identification and assessment of issues based on literature and views of experts.

5. A review of **public and political attitudes** in Europe towards the concept of shared regional repositories. This will be based on input from literature studies by representatives of organisations participating in SAPIERR II, complemented by a review by project team members of the situation in other European countries. An overview will also be prepared on how national programmes now and in the past have tried (or not tried) to encourage public participation in nuclear decisions. The work is linked to Work Package 3 since public attitudes can be strongly affected by local and national benefits.

6. Development of a **Strategy and a Project Plan** for the work of the EDO. The first tasks of an EDO would be agreeing a progressive, staged strategy that would lead to the definition of potential host countries and eventually, to potential repository sites and definition of a parallel science and technology programme that could be addressed by the EDO after its initiation. Obviously the initial stages of the strategy and plan will be specified in more detail during the project; but the entire Plan will be a living document to be updated using input from the studies performed and from the supporting organisations. It is expected that the Plan will be based upon the scenario that the EDO may, after some period, if the participants so decide, convert from a development organisation to a multinational, shared waste management implementation organisation.

7. **Management and dissemination** of information. Contact and consultation with appropriate national bodies and with EC staff is essential to gather the necessary policy and technical input for the project and before judging the feasibility of any proposals for future collaboration. An important component is a final broadly based workshop under the auspices of the EC to present the options to interested countries and organisations, in order to identify potential parties in further collaborative efforts, to achieve consensus on a preferred way forward, and to agree the first steps in its implementation.

### **First results**

The first project meeting took place in Baden, Switzerland, on 29<sup>th</sup> November 2006. The aims of the project and work plan were reviewed. The next meeting of the SAPIERR project participants was held in the Netherlands on 6<sup>th</sup> – 7<sup>th</sup> June 2007 and primarily considered progress on the study of the legal liability issues of international waste transfer within Europe.

- SAPIERR Interest Group (WP7)

One of the first task in the SAPIERR project was to establish the SAPIERR Interest Group (SIG). The aim of the SIG is to strengthen ties to the numerous organisations in other countries that would like to follow the progress of the project. At present, organisations from 13 different EU member states have joined the SIG as well as organisations from Switzerland, Japan and Australia.

SIG members receive any interim or final products of the project that are opened for review. Most important here will be the draft final report, due in mid-2008, which will contain specific suggestions for further work on multinational storage and/or disposal facilities. SIG members can also be asked to provide specific input to task leaders, or to review country-specific data

which are put together by the task leaders. It is important that any proposals put to the EC be based on accurate and up-to-date information.

- Legal and business options (WP1)

The primary goals of this work package are to review the possible forms for an organisation that would further develop projects leading ultimately to siting, constructing and operating a shared European repository that would serve a number of European Member States.

It can not be assumed that a single organisational form will be most suited to all phases of the multi-year implementation process. The primary aim of the current study is to consider suitable legal and organisational forms for the *initial phase* of an EDO - that is for the stages up to formulation of concrete implementation plans. The most crucial pre-condition for moving to implementation is that a repository site has been identified. For the licensing, construction and operation phases, the EDO itself will have to decide whether to stay with its original form or to adopt new structures, staffing and financing for the implementing body, which we label as a European Repository Organisation (ERO).

In the current draft report most emphasis is, therefore, on assessing the benefits and challenges associated with different options for a body that would manage the work over the coming several years, possibly up to the stage of identifying a suitable site or sites for which a license application can be prepared. From the multiple potential organisational forms, a limited number which appear more suitable are proposed as options to be put before the participants in the organisation to be established. Based on the analysis thus far, most likely candidates are a Cooperative, a Consortium or an Intergovernmental organisation. In addition, the requirements on the internal structure and staffing of a repository development organisation are discussed. A final report on this work package is expected in spring 2008.

- Legal liability issues (WP2)

The intention of this work package is to look at the organisational structures suggested for an EDO/ERO in Work Package 1 and to review the actions which may have to be taken during and after the operation of a multinational disposal facility, to consider who shares responsibility for such actions and to look at how responsibilities can best be allocated to ensure that they will be fulfilled in a way which protects future generations from harm, be it physical or financial. In doing this, there is a close link with the financing models for an EDO/ERO that are developed in Work Package 3.

To date, the responsibilities and liabilities of the EDO/ERO have been defined. The key issues appear to be transfer of title, the regulatory interactions and responsibility and liability in case of the waste is retrieved. Some of the issues involved concern legalistic points of title to wastes, contracts at different national and international levels etc. However, this work package does not attempt a formal legalistic analysis but concentrates rather on matters of principle (e.g. intergenerational equity) and practicality (e.g. which organisation is most fitted for any specific task). A final report on this work package is expected in spring 2008.

- Potential economic implications (WP3)

A report is currently being drafted. It includes an overview of costs throughout the backend of the nuclear fuel cycle, an international overview of community benefit packages, possible financing mechanisms for repositories, expected differences between national and regional concepts, and

recommendations for the development possible financing options for repository development. The task also includes a review of national schemes for providing benefits to host communities and an analysis of potential multinational approaches to providing host countries and communities with benefits. The final report on this work package is expected in spring 2008.

- Public and political attitudes (WP5)

The objective of this WP is to review public and political attitudes in Europe towards the concept of shared regional repositories and draw up a communication strategy for the EDO. The emphasis is on the local attitude of shared, regional repositories. A first step was a questionnaire amongst GMF members (the Group of European municipalities with Nuclear Facilities). At two workshops of EC funded European Project “*Local Competence Building and Public Information in European Nuclear Territories*” in Germany (September, 2007) and (Belgium, October 2007), 45 local government representatives from different municipalities of six European countries were interviewed. The questions posed concerned the general level of support for European collaboration to develop a shared repository and also specific issues about siting criteria and procedures.

### **Outlook**

The working group participants will meet a second time in March 2008, to present and discuss progress and coordinate efforts between the work packages. In November, 2007, SAPIERR II representatives were invited to discuss with IAEA officials on the transferability of the SAPIERR regional approach to other regions of the world. The project is to be concluded with an international seminar in Brussels in 2008, open to anybody interested in the topic.

Currently virtually all EU countries, even those with very small nuclear programmes, are under pressure to try to follow purely national programmes, even though the EC and the European Parliament have supported the concept of regional facilities. In fact, the potential contribution of regional facilities to increasing safety, security and economics of disposal has been increasingly acknowledged over the past few years, by various international organisations and also by some national disposal programmes that themselves do not wish to participate in such shared facilities. The objective of the seminar will be to review and disseminate results of the project to a wide audience. The final objective, achieving sufficient consensus on a preferred way towards a European Regional Repository, should be achieved through interactions at the closing workshop together with bilateral discussions with potential participants in an EDO.

At the end of the project, the SAPIERR shared storage and disposal concept will have been developed to a level where either:

- future work could be handed over to the suggested new multinational EDO, thus establishing a firm basis for progress, or
- content and timing are defined for further actions required before an EDO can be established or
- the participants conclude that further efforts are not productive in this area at this time.

Any of the three of the potential outcomes mentioned in section 3 would have a large impact on subsequent European work on disposal and hence on public attitudes to nuclear power. If an EDO



were to be established soon, then intensive co-operation leading to significant cost reductions could result. If further study is needed, this will also be done through co-operation between countries. If it is decided that regional repositories are not realistic, pressure will increase on various small EU countries to initiate or build up national disposal programmes.

The project can also promote the harmonization of standards governing the implementation of geological repositories and other facilities. A regional facility will have to satisfy the safety standards not only of its host country, but most likely also of all of the user countries. Precedents already exist for national policies which lay down that any facility to which waste is exported must satisfy the standards of the exporting country.

### **References**

- [1] Christina Boutellier, Charles McCombie: Legal Aspects, SAPIERR report – deliverable No.2, August 2004, <http://www.sapierr.net>
- [2] Vladan Stefula: Inventory, SAPIERR report – deliverable No.1, September 2004, <http://www.sapierr.net>
- [3] Neil Chapman, Charles McCombie, Vladan Stefula: Possible Options and Scenarios of Regional Disposal and Future RTD Recommendations, SAPIERR report – deliverable No.3, September 2005, <http://www.sapierr.net>

Pictures

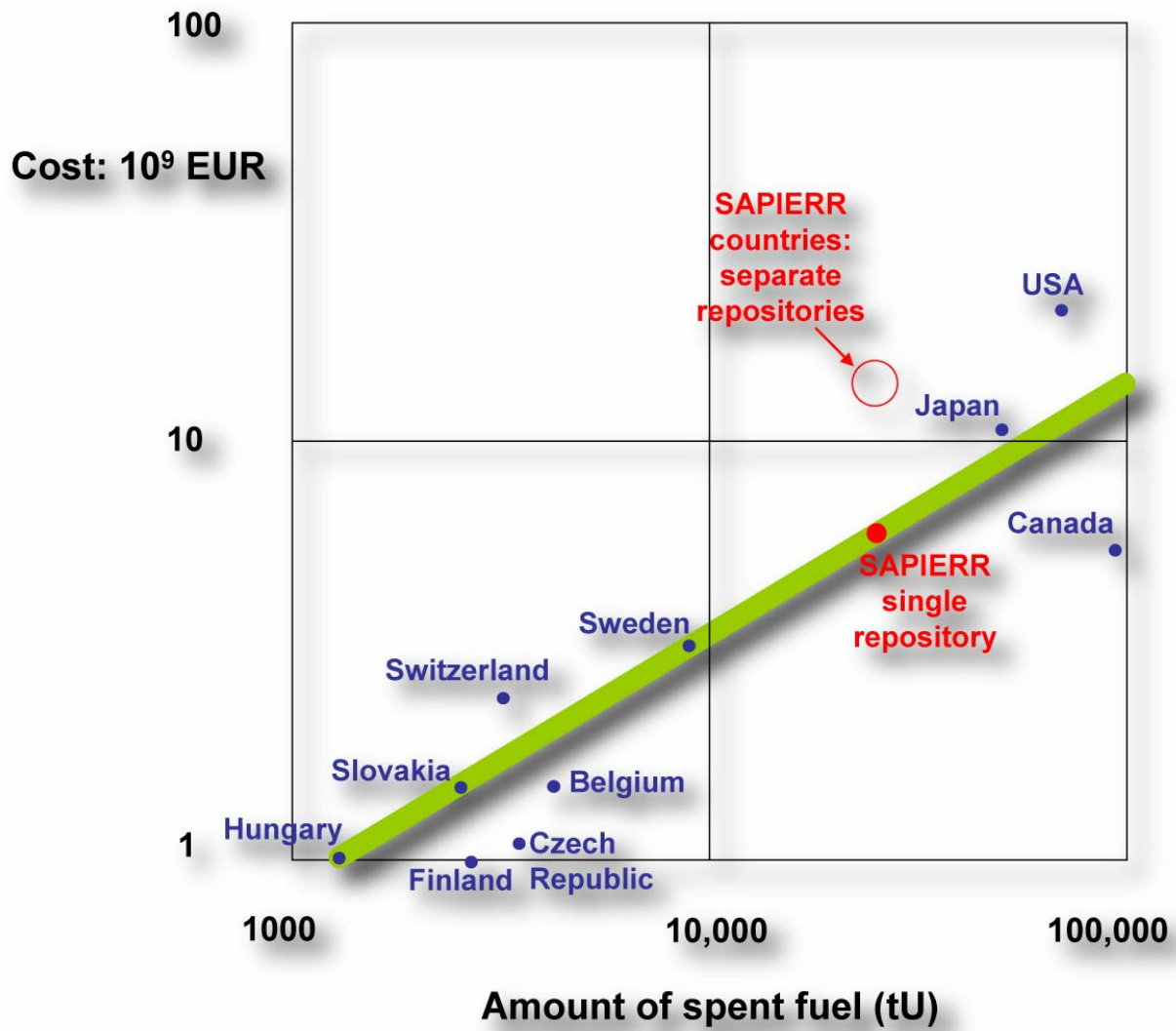


Figure 1: Deep repository costs as a function of quantity (spent fuel only)

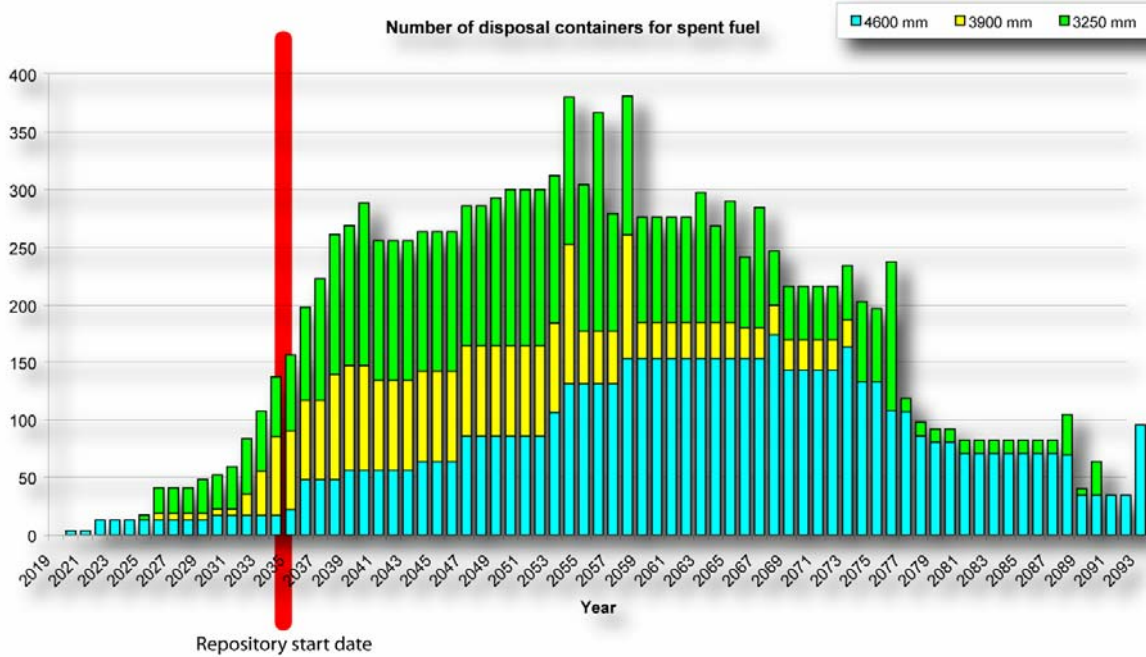


Figure 2: Production of spent fuel in SAPIERR countries, when spent fuel is packaged after 50 year storage

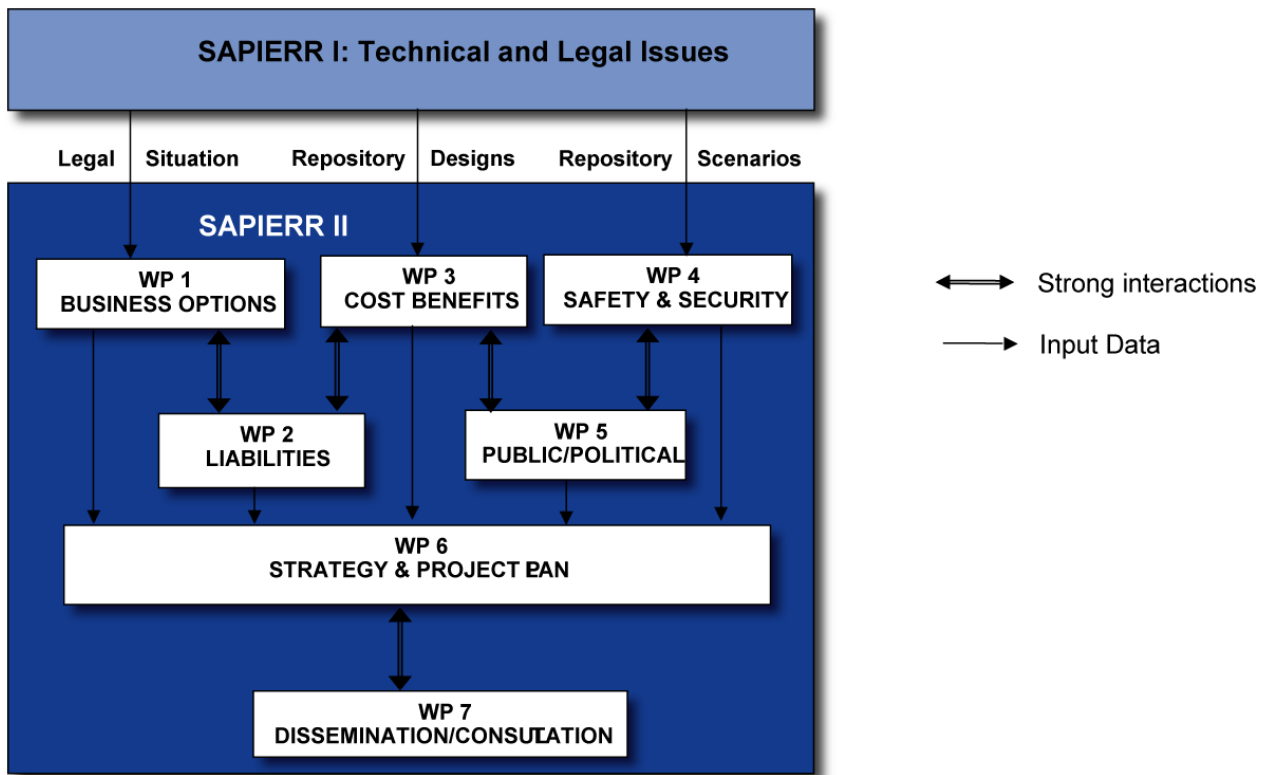


Figure 3: Schematic overview of SAPIERR work plan