

Submitted 14 March 2018 by the Minister for Higher Education and Science (Søren Pind)

Proposal for parliamentary resolution

on a long-term solution for Denmark's radioactive waste

The Danish Parliament notifies of its consent for the Government to implement a solution for Denmark's radioactive waste with the objective of upgrading the Danish

Decommissioning storage facilities at the Risø peninsula and to prepare the localisation and implementation of a deep geological final repository to be in operation by 2073 at the latest.

Notes on the resolution

Contents

- I. Objective of the proposal and background
 - 1. Objective of the proposal
 - 2. Background
- II. Development of a long-term solution for Denmark's radioactive waste
 - 3. Entire account of the proposal for a long-term solution for Denmark's radioactive waste
 - 4. Basis for the proposal for a long-term solution for radioactive waste
 - 5. International obligations
- III. Upgrading the storage facilities at Risø
- IV. Expansion of Danish Decommissioning's activities
- V. Geological surveys of depths of 500 metres
- VI. Localisation of final repository
- VII. Establishment of a deep geological final repository
- VIII. Plan for stakeholder involvement
- IX. Continued exploration of international solutions for special waste
- X. Economic conditions for a long-term solution

Appendix A Overview of background material

I. Objective of the proposal and background

1. Objective of the proposal

The Danish Government requests that the proposal for parliamentary support will allow for the implementation of a long-term solution for Denmark's radioactive waste with the objective of upgrading Danish Decommissioning's storage facilities at the Risø peninsula and thereby that a final repository can be operational by 2073 at the latest. The final repository must be constructed with a view to it being able to accept all types of waste in the Danish waste inventory, including long-lived waste fractions from burnout tests at the Risø Research Center in the form of post irradiation waste, which is considered special waste.

Implementation of a long-term solution must provide clarity about the future management of radioactive waste in Denmark and ensure that the waste is treated in accordance with international obligations, which Denmark has committed to regarding radioactive waste, in particular *Council Directive 2011/70/EURATOM of 19 July 2011 on establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste* (Spent Fuel and Radioactive Waste Directive), as well as the International Atomic Energy Agency's *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* of 1997, which Denmark signed in 1999 (Convention on Nuclear Safety).

In commencing the task now, one can utilise the knowledge and competences acquired by Danish Decommissioning within the field since the group's inception in 2000 and thereby avoid knowledge gaps from further postponing a long-term solution.

2. Background

By accepting the 2003 parliamentary resolution B 48 on the decommissioning of the nuclear facility at Risø Research Center, the Danish Parliament decided that the decommissioning of the Risø facility should be completed within a timespan of 20 years, and that a Basis for a Decision should be developed for a final repository for low- and intermediate radioactive waste. Furthermore, the Government wants to investigate the possibility of an international solution, including export, for special waste and thereafter put the case to the Parliament.

The radioactive waste that Danish Decommissioning will have following the decommissioning of the Risø facility will comprise a total of approx. 10000 m³ including packaging and include the following categories:

- Waste from the development of the nuclear facility at Risø Research Center,
- Solid waste, radioactive equipment and discarded radioactive sources stemming from the health sector, research and industry, delivered for treatment by Danish Decommissioning
- Waste product from water treatment at Danish Decommissioning's treatment station
- Special waste with a long decaying period, primarily post irradiation waste from the testing company at Risø Research Center.
- Waste material from uranium extraction tests as well as unused uranium ore and NORM waste (naturally occurring radioactive materials) from the mining industry and other sources.

A final repository could also be considered for housing NORM waste, which is currently stored by the waste owner until disposal can be secured. The radiation protection authority monitors the storage of waste by the waste owner, who is responsible for ensuring that storage is safely maintained.

In 2009, the Parliament examined report R 4 on a Basis for a Decision for a final repository and gave its support for continuing preliminary studies of possible types of repository and studies of possible locations for a final repository in Denmark.

In 2011, preliminary studies for a final repository proposed preliminary safety analyses as well as a description of different types of near-surface and medium-depth repositories of up to 300 metres. Studies of possible locations identified six possible locations, which were recommended for further geological studies.

In 2012, surrounding studies were proposed for the six possible locations for the final repository. The political parties decided on 21 November 2012, that an environmental assessment should be carried out of the planned basis for a final repository and assess the localisation of one or more of the six possible locations. Furthermore, it was decided to investigate the possibility of exporting all Danish radioactive waste - and not just the special waste - abroad. Finally, it was decided to investigate the possibility of storing the radioactive waste in an interim facility for up to 100 years, similar to that in the Netherlands, where the long interim period is conditional on the continued operation of a nuclear power plant until 2033, after which decommissioning will begin.

In 2014, an environmental assessment of the planned basis for a final repository was carried out which concluded that it was not possible to identify a location from the six possible locations without carrying out further studies.

In 2015, a Basis for a Decision was taken for an interim storage facility, which concluded that it would be possible to establish a secure interim facility for the radioactive waste, after which it would be placed in a final repository. In the same year, and after exploring possibilities in the 23 OECD countries, it was concluded that export of the total amount of waste was not realistic due to the legal, technical, and/or political obstacles for such a solution.

Following this, the political parties decided on 11 March 2015, that further studies of an interim storage solution should be carried out to inform on the safety, economy and operation of an interim facility for 100 years, with a view to comparison with a final repository solution. It was also decided to suspend work on a final repository solution in order to wait for the comparisons arising from further studies of an interim storage solution. Furthermore, it was decided to continue investigating options for selling the special waste with an aim of finding a final repository abroad.

In 2016, results of the new interim facility studies were available in the form of a report on the safety, economy and operation, where the safety and cost level of an interim facility and a final repository were compared. The interim solution studies also included a report on the criteria and process for the localisation of an interim facility. A summary of interim facility studies was drafted on the basis of the total report material developed for the case since the Basis for a Decision for a final repository began in 2008 and presented a number of recommendations for further action in the case.

The continued exploration of possibilities for selling special waste abroad showed that it was not realistic to continue operating with this method.

In 2017, a cross-ministerial working group drafted a report for the Minister of Higher Education and Science on the collective interim storage studies. The working group determined that both a final repository and an interim storage solution of up to 100 years could be constructed and operated in a satisfactory manner in relation to the protection of mankind, the environment and the physical facility.

The working group pointed out that any decision on a long-term interim solution should be clearly connected with a subsequent planning and implementation of a final repository as the ultimate objective for a long-term solution. This owing to Denmark's international obligations in relation to management, storage and final disposal of radioactive waste. Meanwhile, it is crucial for the most suitable management of radioactive waste in the interim storage period, that there is a clear objective with the storage, so that appropriate resources and competences can be utilised for the realisation of the long-term solution.

On 19 September 2017, the Government published its proposal for a long-term solution with the aim of adopting a new parliamentary resolution in the case.

II. Development of a long-term solution for Denmark's radioactive waste

3. Overall description of the proposal for a long-term solution for Denmark's radioactive waste

The Government's proposal for a long-term solution has been prepared from an evaluation of the necessary initiatives in the short-, medium-, and long term.

In the short-term, the Government proposes that the storage facilities at Danish Decommissioning are upgraded with the objective of storing radioactive waste under adequate conditions with regard to protection from flood tides, climate control, and increased waste volume in line with the development of facilities at Risø. A decision must also be taken on the objective and tasks of Danish Decommissioning in relation to a long-term solution, which requires an expansion of Danish Decommissioning's legal authority to also include contributing to the process of finding a long-term solution.

In the medium term, the Government proposes that studies of Denmark's geology to depths of 500 metres be carried out with the aim of identifying potential locations for a deep geological final repository. After which, the final localisation should be determined from a precise analysis of a number of criteria including geological, physical and socio-economic, with weight given to safety as a significant component for the final localisation. In parallel, the Government will continue to explore possibilities for an international solution with regard to the disposal of special waste abroad, either through the export of waste via a bilateral agreement or through participation in an international

disposal solution for long-lived radioactive waste. If an international solution for special waste cannot be realised before a decision is required on the project planning of a deep geological final repository in Denmark, the future planning must include disposal of special waste within Denmark.

In the long term, the Government proposes that a deep geological final repository be established on Danish soil to be operational by 2073 at the latest. The Government proposes that a deep geological repository at a depth of up to 500 m be planned, similar to solutions in Sweden, Finland and France, where facilities are being prepared. A Danish final repository of this type would be able to benefit from the experience of these countries and would meet the requests for safety and implementation from a great number of stakeholders in Denmark and abroad.

4. Basis for the proposal for a long-term solution for radioactive waste

The Government's proposal for a long-term solution for radioactive waste is based on the further studies of an interim storage solution, which the political parties decided to carry out in 2015.

The studies took place in 2016, and included studies of safety, economy and operation of an interim facility for up to 100 years compared to a final repository solution. Furthermore, a separate study of criteria and the process for the localisation of an interim facility was carried out. On the basis of discussions in a forum for significant stakeholders in the case, which was established in 2016, a preliminary report, in association with the interim facility studies, was drafted on the geological conditions to a depth of up to 500 m in Denmark. See Appendix A, No. 2-6, for references to the individual sub-studies. Additionally, see Appendix A, No. 7-14, for references to the significant documents in the case since the parliamentary Resolution B 48 in 2003 up to the latest involvement of the political parties of 11 March 2015.

The interim facility studies are collated in a report from the cross-ministerial working group under the management of the Ministry of Higher Education and Science, cf. Appendix A, No. 1. The cross-ministerial working group underlined the following conditions of importance for a new parliamentary resolution in the case, cf. Appendix A, No. 1:

- 1) The long-term solution must be implemented observing fundamental principles for radiation protection and safety, including protection of people and the environment, protection outside of national borders, and protection for future generations. The health effects on future generations as a result of the long-term solution must not exceed current acceptable levels. The long-term solution must provide the greatest possible safeguard against unintentional ingress on the basis of risk assessments from all relevant authorities
- 2) The long-term solution must live up to the international obligations that Denmark has regarding radioactive waste
- 3) The long-term solution, no matter its form, and with reference to Council Directive 2011/70/EURATOM, must show consideration for an overall suitable utilisation of resources over time, where the economic burden must be borne by the current generation to avoid any unreasonable burden on future generations
- 4) The long-term solution must allow for an implementation process that, to the greatest possible extent, involves and creates dialogue with central stakeholders during the localisation, establishing, and operation of the solution.

Furthermore, the working group included a number of other prerequisites as the basis for its report, which are provided below.

A long-term interim storage solution as a final repository should be able to be constructed and operated satisfactorily observing fundamental principles for radiation protection of people, environmental protection as well as safety of the physical facility.

Any decision on a long-term interim storage solution would make it possible for Denmark to live up to its international obligations for responsible and safe management of nuclear spent fuel and radioactive waste, so long as the *National policy and program for responsibility and safe management of nuclear spent fuel and radioactive waste in Denmark* (cf. Appendix A, No. 7) describes how a decision on the long-term interim storage solution is clearly linked with a decision on the planning and implementation of a later disposal as the end target for a long-term solution.

Following any decision on a long-term interim storage solution, the national program should provide argument for the solution being based on sufficient and concrete organisational, knowledge and competence-related, as well as societal and economic advantages that can underpin a deferment of the implementation of a final repository.

The special waste in the form of spent nuclear fuel, which contains the greatest amount of radioactivity in the Danish waste, should be managed as part of a long-term solution on Danish soil, and that this scenario is taken into account in both studies of a final repository and studies of a long-term interim storage facility. Meanwhile, this has led to public debate on the most suitable type of final repository.

Within the forum and in connection with previous consultations about the Danish final repository concept, there has been criticism that the concept has not contained a type of repository for deep geological disposal of up to 500 m deep, but has only described near surface or medium depth types of repository. The criticism has noted that Danish irradiated spent fuel should be compared with spent fuel from nuclear power plants and placed in a deep geological repository of approx. 500 m deep, which is the intention in Sweden and Germany for example. There are currently no actual studies regarding a deep geological repository in Denmark.

However, it should be noted that the preliminary safety analyses in feasibility studies for a final repository have shown it probable that the total amount of waste, including special waste could be safely stored in a medium depth repository.

As a result of the criticism, and in connection with studies of a long-term, interim storage solution, a preliminary report of Denmark's geological conditions to a depth of approx. 500 m has been drafted on the basis of existing data.

It is the assessment of the National Geological Survey of Denmark and Greenland that it would probably be possible to find locations suitable for the implementation of a deep geological repository. It would however, require further studies in the form of drilling and geophysical studies to be able to demonstrate how suitable locations may be found on Danish soil. Such studies should be carried out observing Environmental Impact Assessment regulations.

It is relevant to consider deep geological disposal in Denmark, as this solution could accommodate the aforementioned criticism of a near-surface/medium depth final repository concept not being able to include the total amount of Danish waste.

In any case, there is a need to extend the existing storage facilities, as neither a long-term interim storage solution or a final repository is expected to be ready for operation within Danish Decommissioning's expected closure in 2023. Additionally, flood tide safeguarding of Danish Decommissioning is needed, which necessitates investments in the coming years, so that there is continued storage of the radioactive waste during the period before a long-term solution is implemented and operational.

With regard to possibilities for exporting special waste, which comprises spent nuclear fuel from Research Center Risø, the Ministry of Higher Education and Science - in continuation of previous explorations - requested in 2016 that the Ministry of Foreign Affairs clarify options for exporting special waste. The Ministry of Foreign Affairs on 2 January 2017 and again on 31 January 2018 reported that there continues to be no identifiable realistic possibilities for selling off special waste to other OECD countries and a smaller group of non-OECD countries. This is because of a combination of legal, technical/capacity-related and/or political obstructions in OECD countries, that have previously been contacted. It is noted that at present, there is no prospect for a multilateral solution for disposal of radioactive waste, but Danish Decommissioning will continue to participate in cooperation on any joint European solution under the auspices of the European Repository Development Organisation working group (ERDO-WG).

5. International obligations

Denmark has a number of international obligations with regard to management of radioactive waste. This includes e.g. *Council Directive 2011/70/EURATOM of 19 July 2011 on establishing a Community framework for the responsible and safe management of nuclear spent fuel and radioactive waste* and the International Atomic Energy Agency's *Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management* of 5 September 1997, which Denmark adopted in 1999.

The Council Directive 2011/70/EURATOM outlines that Denmark must dispose of the radioactive waste produced in its own country, and that the disposal should be understood as being brought to a facility without intending to later remove it unless an agreement with another Member State or a third country on the use of a disposal facility in the country in question, cf. directive's article 3, part 1, No. 3) and article 4, part 4. A decision on the implementation of a long-term interim solution should contain a decision on a time for later disposal and it should describe how that process will be carried out and how all necessary resources will be in place in order to implement the final disposal.

The Council Directive 2011/70/EURATOM article 1, part 1, states that the management of nuclear spent fuel and radioactive waste must ensure that future generations are not unreasonably burdened. When deciding on a long-term interim storage solution, it should be evident what the objective of a long-term interim storage facility is so that it can be documented that there hereby will not place unnecessary burdens on future generations.

A Danish long-term solution for radioactive waste will also contribute to realising the UN Global Goals for sustainable development through the provision of a framework for continued secure management of waste in agreement with the agreed international framework (subsidiary goal 12.4), through the maintenance of effective institutions (subsidiary goal 16.6), and inclusive decision-making processes (subsidiary goal 16.7), with regard to the long-term solution.

III. Upgrading the storage facilities at Risø

The Government wishes to obtain Parliament's approval to establish a new flood tide safeguard and climate controlled storage facility on the Risø peninsula with a view to securing storage of radioactive waste until a deep geological repository is operational, after which Danish Decommissioning's facility be decommissioned as soon as possible in preparation for the nuclear supervisory authority releasing the areas for new application without safety limitations.

Establishing a new storage facility on the Risø peninsula is recommended on the following grounds:

- The current storage capacity of Danish Decommissioning is designed based on a final repository being established in 2012. As a result of the progress in the decommissioning work, this capacity is not sufficient to house the amount of waste resulting from the total decommissioning.
- Experience has shown that the two of the current storage buildings are at risk of being affected by a flood tide situation in Roskilde Fjord. This was clear from Storm Bodil in 2013 where the water level reached 2.06 metres above average levels. This led to a requirement from the nuclear supervisory authorities to secure the facilities against flood tides of up to 3.06 metres above average levels.
- The current storage buildings were not established with the objective of taking on longer term storage beyond 2023. The construction of the buildings and layout is therefore not suitable for longer term storage and management of the waste.
- A new storage facility at Risø would make it possible to retain specialist competences and delivery of knowledge at a sufficient level, until the waste is finally placed in a final repository.

IV. Expansion of Danish Decommissioning's activities

The Government wishes to obtain Parliament's approval to take the necessary steps to extend the objective of Danish Decommissioning to also include contribute to establishing a long-term solution for radioactive waste.

Danish Decommissioning's activities are regulated by parliamentary resolution B 48 of 13 March 2003 and Act 122 of 6 May 2003, cf. Appendix A, no. 14 and 15 whereupon and within a timespan of up to 20 years expenses associated with decommissioning activities can be defrayed, along with consultancy from independent consultants as well as supervision of decommissioning. There is a need to provide a foundation for Danish Decommissioning being able to contribute to the long-term solution for the radioactive waste after final decommissioning, including preparation of a final repository.

The Government proposes that Danish Decommissioning receive the necessary authority in the National Budget to be able to contribute to the process of finding a long-term solution, including the authority to be able to defray expenses for activities that form part of this process.

An expansion of the foundation for Danish Decommissioning's activities will additionally support that an effective organisation can continue to be operated for the development and maintenance of Danish competences regarding the processing and safe storage of radioactive waste. Maintaining a sufficient level of both theoretical and practical knowledge is a crucial prerequisite for solving tasks related to radioactive waste.

In a situation where Danish Decommissioning closes in on a decision of decommissioning tasks Risø, it is crucial that a clear future perspective for the organisation can be demonstrated with a view to continuing to be able to recruit and retain the necessary competences.

It is because of these reasons that it is important that Danish Decommissioning has the opportunity to appear as an attractive organisation, capable of gathering and utilising new knowledge from international technological development within the management of radioactive waste.

V. Geological surveys of depths of 500 metres

The Government wishes to obtain Parliament's approval for the Government to initiate surveys of Denmark's geology to depths of 500 metres, with a view to localising a deep geological repository.

The objective of the surveys is to provide clarity on the possibilities of finding geologically suitable locations for a final repository at a greater depth than that previously posited in feasibility

studies for a final repository cf. Appendix A, no. 12. Consultation on *Plan and environmental assessment for establishing a final repository for Danish low- and intermediate active waste* in 2014 showed that there was a desire among Danish and foreign consultation participants to expand the Danish final repository concept to include disposal down to depths of 500 metres to ensure the best possible disposal of long-lived fractionated waste, cf. Appendix A, No. 9. The subject has also been on the agenda in the contact forum [stakeholder forum], where the relevance of new geological surveys has been discussed, also with the involvement of international expertise.

The further plan for carrying out geological surveys of up to depths of 500 metres will be drafted by the Geological Survey of Denmark and Greenland, and will have its basis in a review of existing data with the objective of identifying the most relevant survey locations based on geological criteria. There is a requirement that surveys are carried out on at least two areas and that at least three boreholes are taken at each location. The surveys' duration is expected to take four to five years with commencement of actual survey activity in 2019. The surveys should be carried out observing regulations for environmental impact assessment, just as it is also expected that EU tendering will be used for the geological drilling.

The surveys will attempt to demonstrate and chart a bedrock with low permeability, of a sufficient thickness (more than 100 metres), and which has a horizontal continuous expanse (several kilometres) across the whole survey area. The bedrock must also be sufficiently homogeneous without physical discontinuities such as fissures and faults. Furthermore, the bedrock must be as mineralogically homogeneous and uniform as possible. The geological conditions must be geologically stable in the short and long term.

VI. Localisation of final repository

On the basis of new geological surveys of depths of up to 500 metres, a re-evaluation of the existing basis for a Danish final repository must take place, with the view to implementing a final localisation of a deep geological final repository, while observing that safety considerations are given the strongest weight in the final localisation decision.

Safety surrounding a final repository is based on the repository consisting of a number of physical and chemical barriers, which have all been chosen so that they, to the greatest possible extent, prevent, hinder and delay any release from the repository to its surroundings without further human intervention and ensure that at all times people and the environment are not exposed to any radiation levels above those as determined by the nuclear supervisory authorities, cf. Appendix A, No. 6.

Barriers in a final repository consist of:

- waste containers with waste and filling material
- repository building with waste containers and filling material
- the surrounding geology.

To ensure a final repository is as secure as possible, it must be filled with a filling material once all waste has been placed in the repository. Once a final repository is closed, people cannot and therefore must not go into the repository. However, there must still be monitoring of the final repository and precautionary control measures will be taken by the nuclear supervisory authorities.

When the relevant locations for geological surveys to a depth of 500 metres have been identified, a thorough dialogue will be established with the municipalities concerned. The dialogue will give the municipalities the opportunity to register interests and wishes. The dialogue, will concern prerequisites and conditions for making a localisation decision with a view to implementing a process with the greatest possible consideration for local circumstances and the interests of the municipalities.

As part of the dialogue, a process will be carried out where municipalities with relevant survey locations will have the opportunity to express interest in entering a partnership on the study of technical, environmental and socio-economic conditions in relation to the localisation of a final repository as described in Appendix A, no. 3, 4 and 12.

VII. Establishment of a deep geological final repository

The Government wishes to obtain Parliament's approval for the Government initiating preparation of a deep geological final repository with a view to disposal of long-lived radioactive waste. It is assumed that an actual localisation of a final repository can take place on the basis of new geological surveys.

The starting point for the establishment of a final repository will come from the process that was outlined in the feasibility studies for a final repository, cf. Appendix A, no. 12 which can be summarised as follows:

1. Approval of the planning legislation
2. Environmental impact assessment and outline planning
3. Proposal for and approval of facility legislation
4. Detailed project design and tender
5. Land acquisition and implementation
6. Commissioning, operation and maintenance
7. Monitoring

In the planning phase, consideration will be given for the possibilities for separate solutions for individual waste fractions. Because of the high level of radioactivity and long-lived nuclides, special waste will be defining for this work. In the feasibility studies for a final repository cf. Appendix A, no.12, chapter 4, solution models have been described where a number of repository constructions have been combined into 18 possible types of repository. Combined with the new geological surveys of depths of up to 500 metres, these types of repositories will be the starting point for developing a proposal for the planning of a collective repository facility.

Before submitting the proposal for the planning legislation, a proposal must be drafted for the specific type of final repository to be established. The final repository will be planned, so that a repository section is established with the aim of filling it with the existing radioactive waste, particularly the special waste and other long-lived forms of waste. This facility can thereafter be closed and sealed, whereby the disposal process will be completed for the waste fractions with the highest radioactivity.

With regard to receiving and disposing of future radioactive waste from users of radioactive material (hospitals, research labs and industry), the final repository facility will include a reception station connected to a repository section, which will gradually be filled, after which it will be closed and sealed.

The planning can take into account a possible need for future extension of the facility with a proposal for acquisition of extra land for a new repository section.

The latest evaluation of the amount of future waste, cf. Appendix A, no. 6, p. 19, estimates that approx. 8 m³ of waste from the health sector, industry and research institutions will be submitted. Generally, the amount of new radioactive waste is expected to be gradually smaller as a result of technological development, which can allow for the replacement of radioactive sources with other solutions.

The final repository is planned to be operational by 2073 at the latest. The long time-frame is due to uncertainty about the concrete course of the localisation and planning process. Likewise there remains an outstanding final characterisation of the historical radioactive waste at Danish Decommissioning. Drafting of a safety case for a final repository prior to operational permission is also considered to be time-consuming based on international experience. A more detailed time frame can be developed when the result of the geological surveys of depths of 500 metres are available.

VIII. Plan for stakeholder involvement

The Government wishes to obtain Parliament's approval for the overall process being carried out with continual involvement of significant stakeholders in a Danish final repository for radioactive waste.

In it additional to the statutory involvement and consultation of the public in different stages of the process ahead of realising a long-term solution, the involvement of stakeholders will include the continuation and adaptation of a contact forum in the case in line with developments, comprising a dialogue forum and communications resource at the final location for a final repository. Operation of a communications platform with access to all relevant material in the case, and with a contact person function will also be included in the plan for stakeholder involvement.

IX. Continued exploration of international solutions for special waste

The Government wishes to obtain Parliament's approval for the Government, prior to the initiation of construction of a deep geological final repository, continuing to explore possibilities for an international solution for the disposal of Denmark's long-lived radioactive waste.

Previous efforts to sell off the Danish radioactive waste either in part or whole to abroad have not shown the possibility for such a solution. The Ministry of Foreign Affairs has explored possibilities for exporting radioactive waste to selected countries during the period 2013-18, but had to conclude that so far it has not proven to be realistic to export the waste as a result of legislative, technical, and/or political conditions in these countries.

The Government will continue to investigate possibilities for joint international solutions – including possibilities to export the most radioactive Danish nuclear waste to other countries with significantly greater amounts of radioactive waste. At the request of the ministry responsible for the area, the Ministry of Foreign Affairs will continue to explore options in the area.

Danish Decommissioning will continue to participate in cooperation on any joint European solution under the auspices of the European Repository Development Organisation working group (ERDO-WG), where joint solutions to technical and analytical problems in relation to management and storage of radioactive waste are being investigated. A joint European solution will ultimately require that a country makes its territory available for a final repository, which has not proven possible so far.

In connection with Danish Decommissioning's engagement in international research and development collaborations, any development of future technological alternatives for a geological disposal will followed closely with a view to potentially adapting the Danish concept for a long-term solution.

X. Economic conditions for a long-term solution

The proposed model entails defraying expenses for an interim storage facility located at Risø, as well as building a final repository, which can be operational by 2073. The total items of expenditure are presented in *table 1* and the expected annual expenses during the period 2018-2037 are presented in *table 2*.

Table 1. Expenditure for a long-term radioactive waste solution until 2122	
<i>(DKK million, 2018 prices)</i>	Expenditure
Final repository	
Surveys of deep geology to 500 metres	80
Localisation	29
Planning and tender	29
Land acquisition	8
Moving radioactive waste	3
Construction and operation of final repository (depreciation provision)	331
Interest for loan limits	441
Operation of final repository	250
Upgraded storage at Risø	
Planning and environmental assessment	26
Project planning and tender	26
Construction and operation of upgraded storage (depreciation provision)	171
Interest for loan limits	232
Operation of upgraded storage	600
Decommissioning and demolition	45
Total expense until and including 2122	2271

The items of expenditure are subject to considerable uncertainty, so far as there is no Danish experience with localisation, project planning and construction of a facility of this character. Additionally, there is the length of the time frame, which means that the profile of expenses can change in connection with the final project.

By estimating the total costs, it is assumed that there will be a final repository in operation by 2073, and that the repository will be written off and yield interest over 50 years, which means that the repository will be fully written off by 2122. After 2122, there will continue to be costs for receiving and disposing of future radioactive waste. The annual expenses for this purpose are estimated at approx. DKK 5 million (2018 prices). Furthermore, it is presupposed that the upgraded storage facilities at Risø will be operational by 2023.

As mentioned under section IV, the Government's model would see Danish Decommissioning being able to defray costs from 2018 for the moving of radioactive waste and for establishing a new storage facility. The estimated costs for moving the interim storage up to the ground and establish a new storage facility, are based on a rapport authored by the COWI consortium, cf. Appendix A, no. 16.

Expenses for 2018, *cf. table 2* will be taken up with the legislation for additional appropriation for the financial year 2018 and costs concerning 2019 and onwards, will be budgeted in the annual National Budget.

Table 2. Annual expenditure during the period 2018-2037*(DKK million, 2018-prices)* **2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037****Final repository**

Deep geology 16.0 16.0 16.0 16.0 16.0

Localisation 13.0 16.0

Project planning and tender 5.0 5.0 6.0 4.0 4.0 5.0

Land acquisition 8.0

Removal of waste*

Construction*

Interest costs*

Operating expenses*

Upgraded storage

Planning, etc. 13.0 13.0

Project planning 13.0 6.0 3.0 2.0 2.0

Construction (depreciation) 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4 3.4

Interest costs 1.3 3.5 4.0 5.3 8.6 8.4 8.2 8.0 7.9 7.7 7.5 7.4 7.2 7.0 6.8 6.7 6.5 6.3 6.2

Operating expenses 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0 12.0

Decommissioning**

Total 42.0 36.3 22.5 22.0 23.3 24.0 36.8 39.6 28.5 28.3 29.1 26.9 26.8 27.6 30.4 22.3 22.1 21.9 21.7 21.6

*Costs related to transporting the waste, construction of the final repository, interest and operation would come into effect after 2037 and are therefore not included.

**Costs related to decommissioning would come into effect after 2037 and are therefore not included.

Overview of background material

- 1) The cross-ministerial working group's report on studies of a long-term interim storage solution for radioactive waste in Denmark. Ministry of Higher Education and Science, Ministry of Finance, Ministry of Health, Ministry of Environment and Food of Denmark, Danish Ministry of Energy, Utilities and Climate, Ministry of Defence, Danish Emergency Management Agency, Environmental Protection Agency, Radiation protection at the Danish Health Authority, Danish Agency for Institutions and Educational Grants, Danish Decommissioning, and Geological Survey of Denmark and Greenland, April 2017.
- 2) Geological conditions at a depth of approx. 500 m. Preliminary report based on existing data. Geological Survey of Denmark and Greenland, December 2016.
- 3) Supplementary long-term interim storage studies – summary. Danish Decommissioning and Geological Survey of Denmark and Greenland, December 2016.
- 4) Criteria and process for the localisation of an interim facility for low and intermediate active waste from Risø. Geological Survey of Denmark and Greenland, December 2016.
- 5) Recommendations for studies of social factors with the localisation of a long-term interim storage solution for radioactive waste from Risø. Danish Center for Environmental Assessment (Department of Planning, Aalborg University) for the Geological Survey of Denmark and Greenland, September 2016.
- 6) Report on the safety, economy and operation of a Danish long-term interim storage solution for radioactive waste. COWI A/S for Danish Decommissioning, August 2016.
- 7) National policy and program for responsibility and safe management of nuclear spent fuel and radioactive waste in Denmark. (Statement to the Commission pursuant to Council Directive 2011/70/EURATOM). Danish Health Authority, August 2015.
- 8) Basis for a Decision for a Danish interim storage solution for low- and intermediate radioactive waste. Geological Survey of Denmark and Greenland, February 2015.
- 9) Plan and environmental assessment for establishing a final repository for Danish low- and intermediate active waste. Danish Ministry of Health and Rambøll, February 2015.
- 10) Surrounding studies of six suitable areas for a final repository (six expert reports). Geological Survey of Denmark and Greenland, 2012.
- 11) Council Directive 2011/70/EURATOM of 19 July 2011 on the Community approach for responsible and safe management of nuclear spent fuel and radioactive waste. Official Journal of the European Union 2 August 2011, L 199, p. 48-56.
- 12) Preliminary studies for a final repository for radioactive waste. Main report. Danish Decommissioning (COWI A/S in cooperation with Studsvik AB and Hasløv & Kjærsgaard), May 2011.
- 13) Statement of 15 January 2009 on the Basis for a Decision for a Danish final repository for low- and intermediate waste (Statement R 4). Discussed in Parliament on 29 January 2009.
- 14) Document 122 - Transfer of tasks and employees from Risø Decommissioning to Danish Decommissioning as well as additional appropriation for the nuclear supervisory authorities. Recommended by the Finance Committee 21 May 2003.
- 15) Proposal for parliamentary resolution on the decommissioning of the nuclear facility at Risø Research Center (Motion for a resolution B 48). Adopted by Parliament 13 March 2003.
- 16) Danish Decommissioning: "Storage solution (30-50 years) for all radioactive waste at Risø". COWI A/S, December 2017.