



# NUCLEAR WASTE MANAGEMENT IN THE EU

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IMPLEMENTATION OF DIRECTIVE 2011/70/EURATOM  
ASSESSMENT REPORT

Update 2023

## Imprint

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# 1 Summary

Nuclear waste remains an unsolved and highly dangerous problem because it needs to be contained safely from the environment for one million years.

In an attempt to solve the nuclear waste problem, an EU-wide regulation was introduced in 2011, the “Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste”. This Directive tried to force EU member states to address the issue seriously, after this had been neglected for decades – thus immediately proving that nuclear waste has never been effectively dealt with.

Since the Directive 2011/70/Euratom came into effect, the *Joint Project – Nuclear Risk & Public Control* is keeping a close watch on the implementation of the Nuclear Waste Directive. Members of Joint Project kept monitoring the implementation on national level and EU level and participated in Strategic Environmental Assessments (SEA), organized events for the interested public and took part in discussion with European Commission representatives and the public at the Aarhus Round Table on Radioactive Waste Management in January 2021. The **assessment report “Nuclear waste management in the EU. Implementation of Directive 2011/70/Euratom”** presents the results gained the monitoring. Thanks to the Vienna Ombuds Office for Environmental Protection and the Cities for a Nuclear Free Europe the report was updated extensively.

Until 2015 every member state had to develop a national programme for the management of nuclear waste; out of formerly 29 EU countries only three (Finland, Luxembourg, Slovakia) managed to implement this Directive, while all other countries faced infringement procedures. Even so, Finland has still not solved the issue of copper corrosion, Slovakia has not even started the search for a repository site and continues examining the export option; Luxembourg exports its nuclear waste to Belgium which also has not fulfilled the obligations of the Nuclear Waste Directive.

The European Commission (EC) published two Nuclear Waste Directive implementation reports (2017, 2019; 2021 has not yet been published). In its 2019 implementation report the EC stated that progress has been made, but “[H]owever, more needs to be done” and presented a long list of necessary remedies to be delivered by the member states. The 2019 EC report did not show significant progress compared to the 2017 report, the key issues have not been solved. The EC listed the deficits and challenges it encountered in the member states’ nuclear waste programmes:

- Swift decisions on national policies, concepts and plans should be taken, especially for intermediate level waste and high-level waste.
- Member States that consider shared solutions should cluster up and take practical measures, including on site-specific matters.
- Member States must ensure sufficient funding for the costs of the national programmes.
- Classification schemes must be harmonized.
- Many member states’ reports delay the implementation of the programmes. Clear key performance indicators are needed for monitoring progress to avoid further delays.
- The inventory projections must be improved.
- The independence of the nuclear waste regulator must be demonstrated or established in the first place, including allocating sufficient financial and human resources.
- Outcomes of peer reviews and self-assessments should be shared, and a transparent dialogue with stakeholders is necessary.

- Research, development and training also remain important when it comes to delivering long-term solutions for intermediate level, high level waste and spent fuel management.
- Many Member States need to improve the quality of their national reports.
- The EC will follow up the work of the Member States and take legal action if necessary.

Also unsolved: The ultimate responsibility for the spent fuel over very long time periods is not ensured, the post-closure period of deep geological repositories has not been addressed, repository site selection will take too long in some member states.

As in the field of nuclear power plant safety, international cooperation and peer reviews take place for nuclear waste programmes, among them the IAEA ARTEMIS missions. Problems became visible in nearly all sectors that were assessed. Peer review results provide valuable information on shortcomings, but the public has no possibility to follow up if the recommendations and suggestions have been implemented, except to wait for a follow-up mission which might take place only years later: Countries may or may not agree to making the mission's result public.

A very important topic is transparency. One of the newly introduced features of the Directive 2011/70/Euratom is article 10 (1) on transparency: *"Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public."* The report shows that even from the European Commission's side transparency has not been guaranteed throughout the process. The reasons for infringements procedure against member states' implementations have not been made public, and national programmes and reports are published with significant delays or not at all.

Transparency and public participation could be increased easily with an existing and tool, which is obligatory for plans and programs in the framework of the ESPOO Convention: the SEA (Strategic Environmental Assessment), however, many countries chose to avoid this, the EC chose to not enforce an SEA. At the same time, **participation in the decision-taking** process is of uttermost importance for the public, and member states had to include measures for transparency and public participation in decision-taking in their national programmes in line with Art. 10. of the Directive– if these measures will enable effective participation remains to be seen.

**Inventories of nuclear waste remain incomplete**, already in 2017, the EC criticized that *"a number of member states have not reported on all types of radioactive waste, particularly radioactive waste originating from decommissioning and new builds, future forecasts and institutional waste."*

Usually, management concepts include **timeframes and monitoring of progress**. However, national waste management programmes seem to be lacking such basic management instruments. Regarding final disposal of spent nuclear fuel, some countries still refer to the so-called shared solution – under the ERDO association's lead – where countries could build a multinational repository in one of ERDO's members. A problem for this solution is that many countries have laws in force forbidding import of nuclear waste, and that all relevant questions are not solved yet – how such a shared facility should be financed, regulated, insured, etc. Some member states are exporting their spent nuclear fuel to countries with questionable nuclear waste management practices (like the infamous Mayak facility in Russia).

One of the general principles of the Nuclear Waste Directive is laid down in Article 4 (3)e: *“the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials”*. Article 12(1)h requires member states to provide *“an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time”*, and according to Art. 12 (1)i *“the financing scheme(s) in force.”*

Costs arise during all phases of nuclear waste management. As there is no operable repository for spent fuel and HLW yet, the costs for such a facility are highly speculative. Nevertheless, it is clear that costs will be high, that the cost estimates continue rising and enormous funds have to be accumulated.

**While in the 2017 EC Report total costs were estimated to 400 bn euros, the estimate of 2019 was already significantly higher at 422-566 bn euros.** It can be assumed that this number will have to be adjusted upwards in the next reports.

With its 2019 report the EC confirmed what is widely been known by independent experts and suspected by the public: many member states do not have reliable data about the future costs of their nuclear programmes' back-end and certainly do not have the financial means to cover them. The key question – who will pay for waste management once the dedicated funds have run dry in particular once the waste generators after decommissioning of the last NPPs will have stopped their contributions into those funds. There will hardly be another solution but making the taxpayers pay.

#### **Is Finland's spent fuel repository a “game changer” for the nuclear industry?**

The game changer claim refers to the supposedly upcoming start of the spent fuel repository in Finland, called Onkalo. The solution applied there foresees the Swedish KBS-3 method of using copper canisters. However, there are independent scientific studies showing that the copper canisters may corrode much faster than originally assumed and have not been licensed yet. Also, copper is also rather expensive, some countries already announced they refrain from this option for financial reasons (Czech Republic).

Concerning funding, a simple comparison shows how little the Finnish solution – if ever to come true – means to the overall situation the nuclear industry finds itself in: The official Finnish data show that the Onkalo repository construction and development costs reached 5 billion euros and should store 6,500 t of spent fuel. Have other countries accumulated comparable funding in their national nuclear waste funds or have they ensured to have them ready in time? As the Czech Nuclear Waste Agency noted in its 2019 Nuclear Waste Strategy: *“when estimating the economic demands, it is necessary to understand (...) that a range of insecurities enters the calculation. These insecurities are not only technical, but also due to unusually remote time horizons, lying significantly beyond standard planning periods”* (RAWRA 2019).

The Czech Republic planned 3.1 billion euros for the construction of the deep geological repository (DGR); however, only 1.1 billion have been accumulated to date.

Germany is another interesting example for not secured financing. While Germany has the advantage of a clearly determined amount of spent fuel because of the 2022 completed nuclear phase-out, the necessary sum is not secured. The 24.06 billion euros in the German fund for the management of nuclear waste (KENFO) need to be invested in such a manner that the broad estimated range of 169 to 182 billion euros will be the return of this investment at the end of the century – and it is not sure if the necessary interest rate can be reached.

Clearly, the member states are not applying sufficient efforts to solve the nuclear waste situation. This became visible when the EC draft taxonomy Delegated Act 2021 proposed that EU countries have to come up with a plan to ensure the operation of a Deep Geological Repository by 2050. But member states protested against having to plan for a final disposal in 30 years, because they try to postpone this even further into the future. However, one exception: The Czech Republic is now striving to open its final repository 15 years earlier than previously planned; the tight schedule makes cutting down on research and geological investigations necessary.

The unsolved nuclear waste problem is one of the key factors why nuclear energy is no sustainable energy solution.

## 2 Introduction

**Nuclear waste remains an unsolved and highly dangerous problem which will stay with us for a minimum of one million years.**

In 2011 the **“Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste”** introduced an EU-wide regulation to solve the nuclear waste problem. (see Annex 1) This Directive tried to force EU member states to address the issue seriously, after this had been neglected for decades – thus immediately proving that nuclear waste has never been effectively dealt with.

The Directive had to be transposed into national law by the member states until 23 August 2013. Until 23 August 2015 every member state had to develop a national programme for the management of spent fuel and radioactive waste, based on a national policy and a national framework. Every three years, a national report has to be submitted to the European Commission (EC) to document these activities, the first in August 2015, the second in August 2018 and the third in August 2021.

Nearly two years after the first deadline of 2015 has passed, the EC published its first report on the implementation of the Nuclear Waste Directive on 15 May 2017. A second report followed in December 2019. Both reports found that Member States are far from achieving the goal of solving their waste problem. In its second report, the EC stated that progress has been made, but **“[H]owever, more needs to be done”** (EC Report 2019, p. 17) and presented a long list of necessary remedies to be delivered by the member states.

Since the very first steps, the Joint Project – Nuclear Risk & Public Control<sup>1</sup> is keeping a close watch on the implementation of the Nuclear Waste Directive. Members of Joint Project kept monitoring the implementation on national level and EU level and participated in Strategic Environmental Assessments (SEA), organized events for the interested public and took part in discussion with European Commission representatives and the public at the Aarhus Round Table on Radioactive Waste Management in January 2021.

Our 2022 report was a substantive update of our earlier reports and made possible with the financial support of the Vienna Ombuds Office for Environmental Protection (WUA).

The present 2023 report provides updates on the infringement procedures, the recent ARTEMIS mission results and major development in several countries’ nuclear waste managements.

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<sup>1</sup> <http://www.joint-project.org/>



## 3 Member states' poor implementation of the Directive

This chapter describes the EU member states' general implementation of Directive 2011/70/Euratom. If a member state does not implement European law correctly, the European Commission starts an infringement procedure. The chapter provides the list of infringement procedures (active and closed cases). In addition, the EC assessed member states' implementation in two reports – their key conclusions can be found in the second part of this chapter.

### 3.1 Infringement procedures

Directive 2011/70/Euratom had to be implemented into national law of the EU member states until August 2013, and the first national programmes had to be submitted to EC until August 2015. The EC is not satisfied with the content of most of the national programmes. **As of July 2023, 18 EU Member States have active infringement procedures**, nearly all of them for “Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom)”; some member states have (additional) infringement procedures due to non-conformity of legislation.

**These 18 active infringement cases for failure to adopt a national programme compliant with the Nuclear Waste Directive show the enormous need for action on EU level.** Since the last overview of the status of infringement procedures in the frame of this report in November 2021, not a single one of these cases had been closed – on the contrary: some member states reached the next infringement level by receiving a reasoned opinion<sup>2</sup>.

Table 1 on the next page lists all active infringement procedures in relation to the 2011/70/Euratom implementation as published in the EU's infringement data base.

Out of formerly 29 (now 28) member states only three implemented the Nuclear Waste Directive in such a way that they avoided an infringement procedure. These three states are Finland, Luxembourg and Slovakia.

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<sup>2</sup> Infringements follow a special procedure: Firstly, a formal notice is submitted by EC to the member state. In case of no remedy, then, secondly, a reasoned opinion is submitted. And if this also does not result in solving of the problem, the member state is, thirdly, referred to Court.

Table 1: Infringement procedures in relation to Directive 2011/70/Euratom. Active cases as of July 2023. Source: EU Infringement Database

Country	Infringement No	Decision	Title	Active case
Austria	INFR(2020)2265	<ul style="list-style-type: none"> <li>30/10/2020 Formal notice Art. 258 TFEU</li> <li>29/09/2022 Reasoned Opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive by Austria	Yes
Belgium	INFR(2018)2013	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>27/11/2019 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Belgium	Yes
Bulgaria	INFR(2018)2017	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>2/07/2020 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Bulgaria	Yes
Croatia	INFR(2020)2267	<ul style="list-style-type: none"> <li>30/10/2020 Formal notice Art. 258 TFEU</li> <li>19/05/2022 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive by Croatia	Yes
Czechia	INFR(2018)2025	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Czech Republic	Yes
Denmark	INFR(2018)2027	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>2/07/2020 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Denmark	Yes
Estonia	INFR(2018)2028	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>19/05/2022 Reasoned Opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Estonia	Yes
Germany	INFR(2018)2015	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>23/09/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Germany	Yes
Greece	INFR(2018)2029	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>2/07/2020 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Greece	Yes

Country	Infringement No	Decision	Title	Active case
Ireland	INFR(2018)2030	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>12/11/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Ireland	Yes
Italy	INFR(2020)2266	<ul style="list-style-type: none"> <li>30/10/2020 Formal notice Art. 258 TFEU</li> <li>19/05/2022 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Italy	Yes
Latvia	INFR(2018)2117	<ul style="list-style-type: none"> <li>7/06/2018 Formal notice Art. 258 TFEU</li> <li>9/06/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	FAILURE TO CORRECTLY TRANSPOSE CERTAIN REQUIREMENTS OF DIRECTIVE 2011/70/EURATOM	Yes
Latvia	INFR(2018)2368	<ul style="list-style-type: none"> <li>24/01/2019 Formal notice Art. 258 TFEU</li> <li>23/09/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Latvia	Yes
Lithuania	INFR(2018)2016	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>2/07/2020 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Lithuania	Yes
Netherlands	INFR(2018)2014	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by the Netherlands	Yes
Netherlands	INFR(2018)2022	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>15/07/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	Non-conformity of the legislation of the Netherlands with certain requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom)	Yes
Poland	INFR(2018)2036	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>15/07/2021 Reasoned opinion Art. 258 TFEU</li> </ul>	Non-conformity of Poland's legislation with certain requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom)	Yes
Portugal	INFR(2020)2315	<ul style="list-style-type: none"> <li>3/12/2020 Formal notice Art. 258 TFEU</li> <li>19/05/2022 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Portugal	Yes
Romania	INFR(2018)2018	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Romania	Yes

Country	Infringement No	Decision	Title	Active case
		<ul style="list-style-type: none"> <li>2/07/2020 Reasoned opinion Art. 258 TFEU</li> </ul>		
Slovenia	INFR(2018)2020	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>19/05/2022 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Slovenia	Yes
Spain	INFR(2018)2019	<ul style="list-style-type: none"> <li>17/05/2018 Formal notice Art. 258 TFEU</li> <li>27/11/2019 Reasoned opinion Art. 258 TFEU</li> </ul>	Failure to adopt a National Programme compliant with the requirements of the Radioactive Waste Directive (Council Directive 2011/70/Euratom) by Spain	Yes

### 3.2 EC assessment of the Member states' implementation

Nearly two years after the first deadline of 2015 has passed, **the European Commission published its first report on the implementation of the Nuclear Waste Directive on 15 May 2017**. This report consisted of three documents (EC Report 2017, 2017a, 2017b).

In this report, the EC highlighted the adoption of the Nuclear Waste Directive as a major step toward achieving a comprehensive and legally binding framework at UE level for the safe and responsible management of nuclear waste. Careful reading of the report points to the following shortcomings:

- Member states did not use the same classification scheme for their inventories.
- Prognosis of future nuclear waste differed in detail and timeframes; some member states have not provided them at all
- Not on all types of radioactive waste have been reported, esp. waste from decommissioning and new builds and institutional waste were not reported
- Member states have not addressed how they will guarantee their ultimate responsibility
- Neither all types of wastes nor all stages of its management were not addressed at all by two third of the member states
- More than half of member states reported to consider a shared disposal solution, but none of them stepped forward with concrete plans or milestones. The EC assesses it as not being in line with the Directive when only the option of shared solutions is being considered.
- The interdependencies between nuclear waste and available facilities for its management have not always been demonstrated.
- Member states which have plans for disposal for their HLW and ILW have failed to demonstrate that their plans do not put undue burdens to future generations.
- In the EC's opinion, certain steps like e. g. repository site selection will take too long in some member states.
- Only about one-third of member states have defined milestones and timeframes; and most have not defined key performance indicators at all.
- The post-closure period of deep geological repositories has not been addressed at all.
- The research plans which were set up to help fulfilling the programmes were not presented.
- Many member states have not notified their existing agreements with other states to the EC yet.
- Some member states don't have independent nuclear safety regulatory authorities.
- Some member states reported limitations in budget and human resources.
- Member states have not provided sufficient information on safety demonstrations of existing and planned facilities, on regular safety reviews and how those findings were taken into account in subsequent reports.
- Member states did not sufficiently describe their licensees' financial and human resources.
- On the long-term, it remains unclear whether and how sufficient expertise and skilled staff will be secured for the future.
- Costs: In the majority of reported costs, the EC was not able to conclude on completeness and accuracy of the reported figures. A much more detailed list of costs should be delivered.
- Financing: The information provided by member states is in most cases insufficient to draw conclusions on their compliance with the Directive. Concerning the security of the available financial resources, member states should report in more detail.
- Half of the member states have not reported on public participation mechanisms beyond public consultations.

- Many member states have not reported concrete plans for international peer reviews.

To overcome these insufficient national management plans, the EC Report of 2017 drew conclusions on four supporting measures the EC intended to provide to member states:

1. The EC stands ready to support member states in discussing options, esp. shared solutions, and public participation in the decision-making process.
2. The EC will compile an overview of total costs and how member states should ensure their financing.
3. The EC will explore possibilities for the harmonization of inventory reporting.
4. The EC sets hopes in the peer reviews and wants to promote open and transparent dialogue and facilitate good practices and knowledge.

These steps were certainly necessary, but by far not enough. If a member state does not fulfil its obligations the EC only has the option of starting infringement procedures which take a long time until a member state is brought to Court. Critical topics like the definition of “substantial changes” were not discussed, neglected topics like the nuclear waste dumping in the Sea have not been brought on the agenda.

The European Commission published a **second report on the implementation of the waste directive in Dec 2019**, also consisting of three documents. (EC Report 2019, 2019a, 2019b). In this second report. the EC stated that progress has been made, but “[H]owever, more needs to be done” (EC Report 2019, p. 17). The following long list of necessary remedies to be delivered by the member states was presented in the report:

- Swift decisions on national policies, concepts and plans should be taken, especially for intermediate level waste and high level waste.
- Member States that consider shared solutions should cluster up and take practical measures, including on site-specific matters.
- Member States must ensure sufficient funding for the costs of the national programmes.
- Classification schemes must be harmonised.
- Many country report delays in the implementation of the programmes. Clear key performance indicators are needed for monitoring progress to avoid further delays.
- The inventory projections must be improved.
- The independence of the nuclear waste regulator must be demonstrated or established in the first place, including allocating sufficient financial and human resources.
- Outcomes of peer reviews and self-assessments should be shared, and a transparent dialogue with stakeholders is necessary.
- Research, development and training also remain important when it comes to delivering long-term solutions for intermediate level, high level waste and spent fuel management.
- Many Member States need to improve the quality of their national reports.
- The EC will follow up the work of the Member States and take legal action if necessary.

**The EC’s third report is expected in 2024.**

### 3.3 International peer reviews to assess national programmes

International peer reviews according to Art. 14(3) are organised as **ARTEMIS missions by IAEA** in close cooperation with EC. It is a voluntary decision taken by the host country whether the mission report will be made public.

These ARTEMIS missions monitor and assess the national waste management programmes and national frameworks of the following member states:

The following countries already completed ARTEMIS missions:

- 2017: Poland
- 2018: France, Bulgaria, Luxembourg, Spain
- 2019: Estonia, Germany, Latvia
- 2020: no missions were completed
- 2021: Ireland
- 2022: Romania, Hungary, Denmark, Lithuania, Slovenia, Cyprus, Malta, Germany (follow-up), Austria, Finland
- 2023: Slovakia, Sweden, Portugal, Croatia, Lithuania (review DGR project)

Upcoming ARTEMIS missions:

- 2023 upcoming: Greece, Italy, Czech Republic, Netherlands, Belgium
- 2024 upcoming: Latvia (follow-up)

All completed mission reports until Feb 2023 are available on the ARTEMIS website.

The IAEA remarks in each mission report: *“The number of recommendations, suggestions and good practices is in no way a measure of the status of the national infrastructure for nuclear and radiation safety. Comparisons of such numbers between ARTEMIS reports from different countries should not be attempted.”*

The number of recommendations, which are stronger than suggestions, may not be comparable, but nonetheless shows that there is indeed need for improvement on very different levels.

For example:

- Bulgaria (2018), recommendation 4: *“The Government should ensure that financial provisions for geological disposal are made.”* This recommendation was made because the peer review team was informed that the cost for geological disposal was not included in the activities covered by the RAW fund.
- Poland (2017), suggestion 1: *“The Government should consider enhancing the transparency of the site selection process for the new surface facility by making publicly available the description of the process for involving the public and potential host municipality at the various stages of site selection”*
- Luxembourg (2018), recommendation 2: *“The Ministry of Health should establish a mechanism to ensure the effective independence of DRP as a regulatory authority from the operational radioactive waste management facility and activities.”*
- Latvia (2019), recommendations 5 and 6: *“The government should establish requirements for the long term storage to ensure that waste is preserved in a condition suitable for its subsequent management.” and “The implementer should further develop specific waste*

*acceptance criteria for the long term storage and set out procedures to ensure that waste is preserved in a condition suitable for its subsequent management*” Latvia has not decided on a plan for the final disposal of the present and future ILW; this type of waste is stored with minimal pre-conditioning. The envisaged period of interim storing the ILW is 50 years, reducing the urgency of solving the ILW disposal. However, this does not allow for the total lack of any no specific activities, including R&D necessary to find a final disposal for this waste. Another IRRS mission found that existing regulations do not contain requirements to ensure the stored waste can be inspected and monitored. Leakages of tritium were detected at the “Radons” facility.

- Slovakia (2023): recommendation 3: *“The Government should establish a programme of proactive involvement of interested parties including the public regarding radioactive waste and spent fuel management, particularly in the siting of a geological disposal facility and its planned evolution.”*
- Slovakia (2023): recommendation 8: *“JAVYS, a.s. should initiate development of an understanding of the features of the geological disposal facility and its host environment that influence safety, to support the siting decision making process.”* The ARTEMIS Review Team was informed that from the five candidate sites, chosen based on the preliminary geological assessment, two have been selected which will be a subject to further investigations regarding the host environment. The remaining three sites are nevertheless still kept as potential future candidate sites. The ARTEMIS Review Team was not provided with clear evidence that an understanding of the features of the GDF and its host environment that influence safety nor a comprehensive set of site selection criteria is available to support these early stages of site selection and its justification.

Problems became visible in nearly all sectors that were assessed. Peer review results provide valuable information on shortcomings. But the public has no possibility to follow up if the recommendations and suggestions have been implemented, except to wait for a follow-up mission which might take place only years later.



## 4 Transparency: Please wait!

One of the newly introduced features of the Directive 2011/70 however is **article 10 (1) on transparency**: “Member States shall ensure that necessary information on the management of spent fuel and radioactive waste be made available to workers and the general public.” To increase transparency the first step should be the timely publication of all national programmes and national reports by the EC and the member states.

By September 2015, only 16 member states had notified their programmes, draft programmes or overviews to the European Commission (EC), even though the EC requested to receive officially approved national programmes. The EC refused to publish those documents. In March 2016, Nuclear Transparency Watch (NTW, a European network for citizen watch on nuclear safety and transparency) requested access to all national programmes and national reports from the EC; this request was met in July 2016. All national programmes and national reports available at that time were made public by NTW: <http://www.nuclear-transparency-watch.eu/a-la-une/access-to-national-programmes-on-radioactive-waste-management.html>.

Meanwhile many of the national programmes and reports are published on DG Energy’s updated website: [https://energy.ec.europa.eu/topics/nuclear-energy/radioactive-waste-and-spent-fuel\\_en#national-programmes-and-reports](https://energy.ec.europa.eu/topics/nuclear-energy/radioactive-waste-and-spent-fuel_en#national-programmes-and-reports)

**But the list of national programmes is still incomplete:** As of August 2023, many countries should have published updated versions of their national programmes, because they undertook major changes in their nuclear waste management policies and plans. However, both Romania’s and Poland’s programme are not available on the DG Energy website. According to the 2019 EC Report, Bulgaria’s programme should have been updated until end of 2019, but the 2015 version instead can be found there.

Another transparency issue is the fact that the **EC does not inform about the reasons** that led the EC to open the mentioned **infringement procedures** when member state’s national programme did not fulfil Directive 2011/70/Euratom. In a parliamentary inquiry an Austrian Member of Parliament asked the European Commission about the reasons of the infringement procedures. In Feb 2019, the then responsible Commissioner Cañete replied that the reasons relate to ongoing investigations and therefore cannot be published. In 2020, NTW tried to get access to the letters of formal notice for several infringement cases, but this was again rejected by DG Energy with the same argument.

## 5 Limited public participation

In most countries, the impacts of the nuclear waste management programmes has not been undertaken. This should have been done in a **Strategic Environmental Assessment (SEA)** for the national programmes. Because most countries have not conducted a SEA, no environmental impacts of the national programmes have been assessed and taken into account. On top in many member states a SEA constitutes the only possibility for the public to participate in the development of the waste management programme.

The EC Report 2019 summarized that *“over half of the member states underwent strategic environmental assessments of their national programmes and over two thirds consult the public in the framework of the environmental impact assessment as a precondition for issuing licenses for nuclear and radioactive waste management installations.”* In Table 1, a list of all countries is provided with the information if a SEA has been conducted. Among the countries refusing to conduct a SEA for their spent fuel and radioactive waste programmes there are many countries with NPPs (Finland, Netherlands, Slovenia, Sweden, UK). Others like Slovakia have reported that they conducted a SEA, but Austria as a neighbouring country has not been notified even though Austria would have participated in a transboundary SEA on Slovakia’s national programme.

A SEA is the only participation procedure on the programme level that focuses on impacts for environment including human health and is legally binding; this is also the case in an Environmental Impact Assessment (EIA) but on the project level. If only two third of member states are planning to consult the public in an EIA for their nuclear waste facilities, this will be the next breach of the Espoo and Aarhus Convention and the EIA Directive of the EU.

**Participation in the decision-making** process is of uttermost importance for the public. The member states had to include measures for transparency and public participation in their national programmes in line with Art. 10. According to the EC Report 2019, almost all states indicated that they have consultation mechanisms in place for certain stages of the decision making. The EC Report 2019 lists the following measures:

<i>Information</i>	<i>Consultation</i>	<i>Participation</i>
Websites	Written submission	Working groups and stakeholders boards
Adapted information products	Web based submission	Local community platforms
Conference and seminars	Oral (public hearings)	Independent advisory bodies
Media relations	Opinion surveys and polls	
Info or visitor centres		
Social media <sup>53</sup>		

Footnote 53: Although social media have the potential to become informal consultation platforms, with their present impact they are rather information channels complementary to the websites.

*Figure 1: Participation measures reported from member states’ national programmes (EC Report 2019b, p. 68)*

While the EC criticized that some member states do not offer any description or examples of effective participation practices, no measure were taken to change this. This failure is not acceptable,

transparency and participation should be enforced as any other article in the directive. The public has to participate effectively including participation in decision-making.

### **Aarhus Convention & Nuclear**

The Aarhus Convention<sup>3</sup> introduced to the public a range of rights with regard to the environment. It provides for a right of access to information on public decisions impacting the environment, a right to participate in environmental decision-making and a right of access to justice should the aforementioned rights be denied.

The ACN (Aarhus Convention and Nuclear) participatory process was initiated in early 2008 by the European Commission Directorate General for Energy (DG ENER) together with Nuclear Transparency Watch. The aim of the ACN process is to investigate the implementation in practice of the Aarhus Convention in the context of nuclear activities. In the ACN Roundtables, various stakeholders like national authorities, technical support organisations, waste management organisations and civil society organisations come together to discuss nuclear issues to improve transparency and participation. In the field of Radioactive Waste Management (RWM), an ACN European Roundtable has been previously held in April 2010.

The European context of public participation in the field of RWM has changed significantly in the last decade. Council Directive 2011/70/Euratom has introduced requirements into EU law for information and public participation in the decision-making process, which reflect the provisions of the Aarhus Convention.

The **second Aarhus Convention & Nuclear (ACN) European Roundtable on information and public participation in the field of Radioactive Waste Management (RWM)** took place from 13<sup>th</sup> to 15<sup>th</sup> January 2021 (online).

The Round Table had three objectives:

- Review the implementation of the Aarhus Convention in radioactive waste management at European level
- Review in particular the implementation of the Nuclear Waste Directive 2011/70/Euratom
- Review in particular public access to research and expertise

The programme included information from EC representatives, country specific information, information on research projects and networks and conclusive remarks.

175 participants were registered from a range of EU countries plus UK, and some from Switzerland, Norway, Belarus, Canada, Japan, and Ghana. No participants from Bosnia & Herzegovina, Croatia, Serbia, Montenegro, Kosovo, Albania, Macedonia, Portugal, Italy, Estonia, Lithuania and Latvia joined the Round Table

Stakeholders present were NGOs, local citizen groups, authorities, regulators, technical support organisations (TSO), waste management organisations (WMO), research entities, EC, members of European Parliament (MEP), lawyers and private persons. Among the speakers, from CEE countries only CZ was represented; and BG for the panel discussion. The Programme Committee was representing mostly western and northern EU countries.

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<sup>3</sup> <https://unece.org/environment-policy/public-participation/aarhus-convention/text>

All presentations can be found here: <http://www.nuclear-transparency-watch.eu/non-classe/acn-round-table-on-rwm-2021.html>

The Joint Project organized a meeting for members of civil society who took part in the Aarhus Round Table. They gave the following feedback on the event (extract from open letter to organizers):

- It was appreciated that the Aarhus Round Table offered participation for a broad variety of stakeholders, and that all participants were together in one (virtual) room
- When discussing European nuclear waste policies, it would be beneficial and actually indispensable for a veritably sincere process to have participants from all European countries on board, who, at the same time, would represent diverse stakeholders within their countries. For example, among the countries of origin of the factual participants those with small radioactive waste inventories from the South and East of Europe were missing. Therefore, for future Round Tables special effort should be made to invite representatives from all stakeholders, including Civil Society's members, and from all countries. If needed, their participation should be supported financially.
- The Round Table's session on the Czech Republic was a good opportunity to shed some light on the differences concerning transparency and participation (T&P) efforts in the Western and Central & Eastern (CEE) countries. For future Round Tables, the debate should concentrate more on T&P in the CEE countries to have this aspect effectively enhanced in the general debate.
- A pluralism of expertise and enabling independent expertise for use by Civil Society are one of the crucial aspects of increasing trust. During the whole Round Table conference, voices were raised for rendering funding for diverse independent expertise. Members of the Civil Society who want to engage in RWM need substantial resources to do so. Especially in the CEE countries, funds for working on nuclear waste issues are currently often unavailable to NGOs. Ms Petrovičová from EC said that the EC heard the clear voice of NGOs for financing of their participation.
- During the Round Table, many important topics concerning RWM were discussed, but some were only touched upon. Military wastes, nuclear waste legacies, (TE)NORMs and uranium waste were not in the focus. Nuclear policies, including the reform of Euratom, should be put on the agenda, too. Effective participation in nuclear power issues is insufficient in many countries. Severe risk for financial burden for taxpayers does persistently exist due to lack of national state's budget resources for RWM, and seriously poor quality cost assessment. Another topic of interest for Civil Society is the post-closure phase of repositories which should also be included in debates.
- To reach results to which all the participants could agree to might be beyond the scope of any Aarhus Round Table. Nevertheless, it would be helpful to define next steps, such as:
  - What will happen until the next Round Table? It would be very fruitful if discussions were pursued also in between the Round Table events.
  - When is the next Round Table planned? A biennial format would be appreciated, including full financial compensation for the organizers' work.
- For future Round Tables, a hybrid format could be used to enable attendance for individuals, especially from the Civil Society, with no budget for covering their travel & participation costs at their disposal.

## 6 Incomplete Inventories and Prognoses

**Which categories of nuclear waste is covered?** There are many types of nuclear waste that need to be managed to keep humans and environment safe: waste from nuclear energy production including decommissioning and legacies, waste from research reactors and their decommissioning, institutional waste (from medicine, research and industry), military waste, waste from uranium production, NORM waste (naturally occurring radioactive material).

But not all of them are in the scope of the national programmes, and for some categories the prognoses are incomplete.

Already in 2017, the EC reported that *“a number of member states have not reported on all types of radioactive waste, particularly radioactive waste originating from decommissioning and new builds, future forecasts and institutional waste.”* (EC Report 2017, p. 7)

In 2019, the situation has only slightly improved: *“As in the previous reporting cycle, the level of detail of information provided by Member States varied considerably, in particular with regard to waste originated from non-power applications and decommissioning of nuclear installations. Since most national programmes cover periods of over 100 years, Member States are encouraged to work on estimates spanning until 2050 and to reduce as much as possible the level of uncertainties that has been observed by the Commission.”* (EC Report 2019, p. 8)

**Future nuclear programmes:** Some Member States are planning nuclear newbuild and lifetime extensions. Both will result in spent fuel and radioactive waste that is not part of the national programmes yet.

*“It has to be noted, that the majority of Member States have not reported inventories from planned new build nuclear power plants.”* (EC Report 2019a, p.27)

For example, for Hungary the ARTEMIS report from 2022 suggested that *“the Government should consider approving an updated national program without undue delay taking into account the Paks II project, and other relevant and technical circumstances.”*

Already before the construction of a new nuclear power plant a review should define the amount of additionally generated waste. Not only additional capacity in existing or planned disposal will be needed, but in many cases new sites for new disposal facilities need to be found, undergo public participation and approval.

**The enormous task of decommissioning the NPP fleet** is in the initial stage. In 2022, only 22 reactors have been completely decommissioned worldwide, out of these only 4 in Europe (Germany). Most of the decommissioned reactors were small or even very small, therefore, assessing the future quantities of decommissioning waste and the costs involved is beset with high insecurities. (WNISR 2022)

The EC reported in 2019 that only about one in five national reports indicated estimated amounts of decommissioning waste separately. (EC Report 2019a, p. 4)

In some member states **radioactive waste from mining and milling** is declared as radioactive waste, others did not include those wastes in their inventory. While the EC comments that is approach is in line with the Directive (EC Report 2019, p. 7), we believe that the Directive should be amended to include all radioactive wastes, also wastes from uranium mining and milling.

Waste containing naturally occurring radioactive material (so-called **NORM**) stems from uranium mining and milling and is not categorized as radioactive waste in some countries. (EC Report 2019a, table I.6)

**Let sleeping dogs lie? Dumping radioactive waste at Sea excluded:** The 2017 Inventory Report (EC Report 2017a, table 1.8) lists activities that have been disposed of into the Sea by several countries before 1975. But there is no further mentioning of this topic, and the 2019 EC Report does not include new information. Many of the dumped drums could and should be recovered. The Nuclear Waste Directive does not explicitly cover this legacy in its scope. If the Nuclear Waste Directive's core message is meant seriously, the ultimate responsibility for these drums still lies with the member states which have dumped them – and therefore they are responsible for recovering as many as possible.

**Unless waste amounts are precisely known capacities for storage and disposal and data on costs and financing cannot be reliably reviewed. Therefore it is necessary that the EU agrees on clear guidelines to include all types of radioactive waste including NORM, waste from decommissioning and generated by planned new nuclear power plants and legacy wastes. Moreover, the scope of the Directive should be broadened to include military waste.**

## 7 Timeframes for Deep Geological Repositories

Usually, management concepts include **timeframes and monitoring of progress**. However, national waste management programmes seem to be lacking such basic management instruments. The EC stated already in 2017: “[...] *only about a third of the Member States have defined clear and detailed milestones and time frames for reaching their objectives*”, and “*Most Member States have not clearly defined key performance indicators for monitoring progress towards implementation of the national programme*” (EC Report 2017, p. 11). Also in 2019, the EC again mentioned that the definition of adequate timeframes and milestones is a challenge (EC Report 2019, p. 15)

In the EC Report 2019, the timeline for the planned operation start of national DGRs was presented.



Figure 2: Planned start of operation of deep geological repositories in EU member states (EC Report 2019, p. 9)

The first three projects are already delayed, and the other Member States seem to have taken refuge in postponing their plans as long as possible to avoid early failures. Some countries with spent fuel from commercial programmes – Bulgaria, Belgium and Italy – have not even indicated a date at all. No progress was made: The very same figure was reported in the 2017 EC Report.

Germany only recently announced that its HLW repository search will last much longer than planned. The site should have been selected by 2031, but now 2046 is the earliest date, another scenario foresees the decision for the repository site only in 2068. The nuclear waste regulator BASE criticized this delay<sup>4</sup>.

In contrast, the Czech Republic decided to speed up its programme and to have an operating HLW repository already in 2050; 15 years earlier than previously planned<sup>5</sup>. This move tries to fulfil the taxonomy criteria for nuclear energy. This accelerated procedure poses a different problem compared to the delays because such time constraints can threaten safety and quality. No mechanisms are in place for such very likely cases if a country fails the intention of having an operable HLW repository in 2050 but has received loans for taxonomy-aligned nuclear projects.

In general, management without timeframes and monitoring without key performance indicators to evaluate progress is very arbitrary. This approach constitutes a clear violation of the EU Nuclear Waste Directive’s aim of ensuring a high level of safety and avoiding undue burdens on future generations.

<sup>4</sup> <https://www.base.bund.de/SharedDocs/Stellungnahmen/BASE/EN/2023/base-statement-time-perspective-site-selection.html>

<sup>5</sup> See also Calla’s presentation of:

[https://res.cloudinary.com/dhymuyvek/image/upload/v1689026058/Edvard\\_Sequens\\_2023\\_05\\_12\\_Czech\\_Republic\\_and\\_Taxonomy\\_compressed\\_79cfd9cd95.pdf](https://res.cloudinary.com/dhymuyvek/image/upload/v1689026058/Edvard_Sequens_2023_05_12_Czech_Republic_and_Taxonomy_compressed_79cfd9cd95.pdf)

## 8 Shared solutions and export

The assessment of national reports showed that **many states are setting their hopes on a multinational (regional, shared) disposal rather than starting their own reliable national plans.**

Also, the European Commission seemingly gave in to member states' wishes and started to support this idea. So far, the multinational repository might serve as a loophole at best, but not as a serious option. To verify the actual status the Joint Project in 2017 conducted a survey among some member states that are or were formerly interested in a multinational disposal. The following member states were contacted: Austria, Bulgaria, Czech Republic, Hungary, Poland, Romania, Italy, Slovenia, Denmark and the Netherlands.

The most important results were:

- Member states are looking for different types of multinational repositories. Slovenia is only interested in a multinational repository for its spent fuel and high-level waste, while Austria hopes that a shared disposal for LILW (Low and Intermediate Level Waste) might be realized in somewhere abroad.
- To some countries, not only shared repositories but also shared conditioning facilities would be of interest.

Therefore, a multinational repository could be not only a single facility, but different facilities that are located on different sites, in the EU and/or outside.

In 2021, the Working Group of the European Repository Development Organisation (ERDO WG<sup>6</sup>) was transformed into the **ERDO association**<sup>7</sup>.

Progress was not made in the past years, again in 2021 ERDO had to admit that not a single of its member countries has volunteered to host a site which would take in also nuclear waste from other countries.

While the Working Group of the European Repository Development Organisation (ERDO) a few years ago had ten members (Austria, Ireland, Netherlands, Poland, Slovakia, Bulgaria, Italy, Lithuania, Romania, Slovenia) this list shrank to only six actively participating members in 2017: Austria, Denmark, Italy, Netherlands, Poland and Slovenia. According to information from the Ministry of Energy in 2018, Poland has recently left the ERDO-WG "due to lack of progress of its work". Romania was a founding member, but it switched to observer status, arguing that the ERDO-WG was not operated by a relevant international organisation.

2023 the new ERDO association consisted of eight member organisations from seven countries; each has different types of nuclear waste:

- ARAO, Slovenia
- COVRA, Netherlands
- Dekom – Danish Decommissioning, Denmark
- ENEA, Italy
- Fond-NEK, Croatia
- NND, Norway
- ONDRAF/NIRAS, Belgium

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<sup>6</sup> <http://www.erdo-wg.com/>

<sup>7</sup> <https://www.erdo.org/>



- IFE; Norway

The 2019 EC report summarized the information from the national reports and concluded that about half of the Member States keep shared disposal solutions as a possible option. (EC Report 2019b, p. 35)

Even though at least half of the member states showed interest in shared solutions they did not join ERDO. The low number of members of ERDO can be seen as an indicator that trust in the shared disposal solution is low. ERDO's activities are limited to issuing newsletters and holding events, mostly reporting about some or other programmes (EURAD, MAGIC, etc.). ERDO has started recently two research projects of its own, one is about borehole repositories, and one on legacy waste characterization. Several years it has not been possible to receive funding for a project on costs of multinational facilities. A joint cooperation with the US DOE is about to start with a first project on Small Modular Reactor Waste impacts on multinational solutions. Research on the "hot topics" of shared solutions (legal and policy questions, costs and financing, liability, participation....) does not move forward.

From the national programmes the EC reported in 2019 that from those who declared interest in shared solutions, *"[h]owever, none of the Member States has reported concrete plans or activities towards implementation of the shared disposal solution. Moreover, discussions on the shared disposal solution are jeopardized due to the fact that most Member States have forbidden by law import of radioactive waste into their territory"* (EC Report 2019b, p 35).

The last sentences deserves particular attention, since countries are trying to find a solution which is legally impossible(!). The EC did not mention which states have a legal ban on waste import; it might thus be legitimate to ask the EC to close this loophole officially and make EU member states fulfil the Nuclear Waste Directive obligations in a legal and realistic manner.

### **Export of nuclear waste**

In the first reading of Directive 2011/70/Euratom EC and Parliament wanted a complete export ban to non-EU countries. In the final version export to non-EU countries was allowed. Art 4(2) stipulates that *"the ultimate responsibility for the safe and responsible disposal of exported materials shall remain with the Member State"*. Spent fuel and radioactive waste can be shipped to another member state or a third country for reprocessing and processing, while the ultimate responsibility remains with the member state from which the material originated.

Of special interest is the question how this ultimate responsibility can be proven if nuclear waste is exported to the Russian reprocessing facility Mayak which is infamous for causing huge environmental damages. One problem with the notification of export occurred in Hungary: The Hungarian SEA showed that export contracts agreed before the Directive 2011/70/Euratom came into force which are not covered by it; thereby contradicting the purpose of the Nuclear Waste Directive, that the ultimate responsibility should remain with the member state of origin. The Nuclear Waste Directive should close this loophole as well and ensure legal certainty.

## 9 Unclear costs and financial burdens for taxpayers

One of the general principles of the Nuclear Waste Directive is laid down in Article 4 (3)e: *“the costs for the management of spent fuel and radioactive waste shall be borne by those who generated those materials”*. Article 12(1)h requires member states to provide *“an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time”*, and according to Art. 12 (1)i *“the financing scheme(s) in force.”*

Costs arise during all phases of nuclear waste management. As there is no operable repository for spent fuel and HLW yet, the costs for such a facility are highly speculative. Nevertheless, it is clear that costs will be high, that the cost estimates continue rising and enormous funds have to be accumulated.

The member states reported to the EC costs and available funds, and the European Commission published assessments in the 2017 and 2019 reports. In the 2019 report (EC Report 2019b, chap. 2.2.4), the EC commented: *“Almost two thirds of the Member States provided information on the cost assessments of their national programmes although the estimates vary widely in terms of the methodology, assumptions, completeness of data, scope and the time frames.”* And: *“Given the lack of completeness of the costs, nor an indication of timing, it is not possible for the Commission to report a consistent figure discounted to the present.”*

**While in the 2017 EC Report total costs was estimated to 400 bn euros, the estimate of 2019 was already significantly higher at 422-566 bn euros.** It can be assumed that this number will have to be adjusted upwards in the next reports.

With this statement the EC confirmed what is widely been known by independent experts and suspected by the public: **many member states do not have reliable data about the future costs of their nuclear programmes’ back-end and certainly do not have the financial means to cover them.**

**The key question – who will pay for waste management once the dedicated funds have run dry, in particular once the waste generators after decommissioning of the last NPPs will have stopped their contributions into those funds. There will hardly be another solution but making the taxpayers pay.**

The following table provides a spotlight on the financial situation of the different national funds in selected countries. The table lists spent fuel in tons of heavy metal, estimated costs for a spent fuel repository, estimated costs for the whole nuclear waste management (including interim storage, decommissioning of facilities, conditioning of nuclear waste, storage and disposal of the low and intermediate level waste etc.). And the last column lists the funds.

Table 2: Overview over funds and spent fuel accumulated versus funds needed in selected countries.

Country	Spent nuclear fuel accumulated as of 2016 in t heavy metal (HM) (year) (EC 2019a, Tab. I.2)	Assumed Repository costs in EUR billion (year) (EC 2019b, Tab 9)	Estimated total costs for spent fuel and radioactive waste management based on national programmes in EUR bn (year) (EC 2019b, Tab 10)	Currently accumulated funding EUR billion (year) (EC 2019b, Tab. 11)
Bulgaria	876 t (2016), 1,496 t(2030) however, more is stored for reprocessing in Russia and will return to Bulgaria	Not available	2.0-4.5 (2015) including decommissioning, spent fuel processing and storage for Kozloduy NPP units 1-4 and 5-6 <sup>8</sup> . The range depends on lifetime extension Decommissioning costs: Kozloduy 1-4: 1.11, 5-6: 1.86 <sup>9</sup>	0.797 (2016), of which 0.74 are for the decommissioning fund
Czech Republic	1,969 t (2016), 9,910 t (>2185) DGR is now planned to accommodate 3,490 t SNF (RAWRA 2019)	4.1 (2011) 3.1 (RAWRA 2019) <sup>10</sup> 6 (2022 <sup>11</sup> )	4.2 (2011), of these 0.147 for LILW; decommissioning is included	1.4 (2011) 1.1 (RAWRA 2019)
Germany	8,849 t (after phase-out 10,110 t)	7.7	66.9 (2012), of these 34 bn for NPP waste, 5 bn for Asse, 2.4-2.7 for Morsleben, 7.5 for Konrad and 7.7 bn for a new LILW repository, for public RAW management 6 bn, 2bn for Gorleben Until 2100: 169 to 182 billion (inflation and interest rate dependent) <sup>12</sup>	24.06 (2017) 22,8 (2020) <sup>13</sup>
Slovakia	1,606 t (2016), 3,380 t (2050)	3.7-4.4 (2014) depending on lifetime extension 4 <sup>14</sup>	8 (2014)	1.2 (2015) 1.92 (2020) <sup>15</sup>
Slovenia	470 t (2016), 900 t(2050)	Not available	0.31 (2005)	0.195 (2016) 0.208 (2019) <sup>16</sup>

<sup>8</sup> It is not clear if the funds Bulgaria is already receiving for decommissioning of Kozloduy 1-4 from EU have been included in this numbers.

<sup>9</sup> Strategy for Specific Nuclear Fuel Management and RAW until 2030), information from Za Zemiata 2021-12-17

<sup>10</sup> The differing figures: the 4.1 from the EC report most likely included more than the DGR, the second clearly is only the DGR. However, the EUR 3.1 bn certainly is too little.

<sup>11</sup> <https://forbes.cz/green-deal-bude-bolet-ale-je-nezbytny-dana-drabova-vyhlyzi-budoucnost-ceske-energetiky/>

<sup>12</sup> Warth & Klein Grant Thornton 2015, GUTACHTLICHE STELLUNGNAHME zur Bewertung der Rückstellungen im Kernenergiebereich

<sup>13</sup> [https://www.kenfo.de/fileadmin/user\\_upload/geschaeftsberichte/kenfo\\_geschaeftsbericht2020.pdf](https://www.kenfo.de/fileadmin/user_upload/geschaeftsberichte/kenfo_geschaeftsbericht2020.pdf), p. 16

<sup>14</sup> [https://www.njf.sk/wp-content/uploads/2020/03/metodika\\_msp\\_a\\_p\\_26\\_02\\_18.pdf](https://www.njf.sk/wp-content/uploads/2020/03/metodika_msp_a_p_26_02_18.pdf), page 15 (Methodical guideline issued by the Slovak National Fond in 2018).

<sup>15</sup> [https://www.njf.sk/wp-content/uploads/2021/05/Výročná-správa-o-hospodárení-a-činnosti-NJF-k-31\\_12\\_2020.pdf](https://www.njf.sk/wp-content/uploads/2021/05/Výročná-správa-o-hospodárení-a-činnosti-NJF-k-31_12_2020.pdf), page 15

<sup>16</sup> Fund for financing the decommissioning of the Krško Nuclear Power Plant and the disposal of Krško NPP radioactive waste and spent nuclear fuel, Report 2019:

<https://www.sklad-nek.si/datoteke/katalogKategorija/letno-porocilo-2019.pdf>, page 56.

As there is no operable deep geological repository (DGR) for spent fuel and HLW yet, the costs for a such a disposal are highly speculative. Finland is the most advanced in the EU in the construction of such a DGR, therefore we compare the Finnish cost estimates with those of other countries who are planning to build a DGR.

### Is Finland's spent fuel Repository a "Game Changer" for the Nuclear Industry?

This claim of the game changer was made by IAEA Director General Grossi in 2020<sup>17</sup> and echoed by many. They refer to the supposedly upcoming start of the spent fuel repository in Finland, called Onkalo. This geological disposal facility is being built close to Olkiluoto, one of the Finland's nuclear power plants. Up to 450 meters below ground level, spent fuel from all of Finland's nuclear power reactors should be isolated for thousands of years, according to the IAEA. The repository is based on the 'KBS-3' disposal concept developed by the Swedish Nuclear Fuel and Waste Management Company (SKB) the IAEA explained.

The Finnish plan foresees using the KBS-3 method. The Swedish KBS-3 method includes using **copper canisters**, assuming that copper does not corrode significantly while covered in clay. But there are independent scientific studies showing that the copper canisters may corrode much faster than originally assumed. This was also recognized by the Swedish Environmental Court in its opinion of 2018. Recent research results give even more proof of copper corrosion. This Swedish technology has not been licensed and the Swedish Environmental Court asked the government to clarify the long-term integrity of the copper canisters, which has not happened yet. Copper is also rather expensive with a strong upwards cost development. Some countries already announced they refrain from going for this option for financial reasons (Czech Republic). Other spent fuel storage canisters (e. g. of steel, bentonite) have not been developed and licensed yet.

**Funding:** A simple comparison shows how little the Finnish solution – if ever to come true – means to the overall situation the nuclear industry finds itself in: The official Finnish data show that the Onkalo repository construction and development costs reached **EUR 5 billion** and should **store 6,500 t of spent fuel**. Have other countries accumulated comparable funding in their national nuclear waste funds or have they ensured to have them ready in time? As the Czech Nuclear Waste Agency noted in its 2019 Nuclear Waste Strategy: *"when estimating the economic demands, it is necessary to understand (...) that a range of insecurities enters the calculation. These insecurities are not only technical, but also due to unusually remote time horizons, lying significantly beyond standard planning periods (RAWRA 2019).*

The Czech Republic has 3.1 billion euros planned for the construction of the DGR; however, only 1.1 billion euros have been accumulated to date. At the same time the same 2019 strategy paper explains the logical fact, that due to the high fixed cost share from total DGR costs, the price per unit (price per ton of disposed spent fuel) is highly dependent on the amount of stored spent fuel. Therefore the storage costs decrease if a larger amount of spent fuel is stored (e.g. from the operation of an additional nuclear power plant). In other words: There is no reason to argue that the Czech repository will cost only approx. 60% from the Finnish one or that this figure is anything but a rough guess. This fact was confirmed by the Nuclear Regulator chairwoman Dana Drábová when in interview on 17 January 2022 she explained that she expects the DGR costs to increase to 6 billion euros<sup>18</sup>.

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<sup>17</sup> <https://www.iaea.org/newscenter/news/finlands-spent-fuel-repository-a-game-changer-for-the-nuclear-industry-director-general-grossi-says>

<sup>18</sup> <https://forbes.cz/green-deal-bude-bolet-ale-je-nezbytny-dana-drabova-vyhli-zi-budoucnost-ceske-energetiky/>

Germany is another interesting example for not secured financing. While Germany has the advantage of a clearly determined amount of spent fuel because of the 2022 completed nuclear phase-out, the necessary sum is not secured. In 2017, the NPP owners transferred 24.06 bn Euro into the KENFO, the German funds for the management of the nuclear waste<sup>19</sup>. According to an expert report for the BMWI from 2015 the 24.06 billion euros have to be invested in such a manner, that the broad estimated range of 169.8 to 182 billion euros(!) will be gained at the end of the century (Warth & Klein Grant Thornton 2015). But this would need an average return of investment of about 3.7 % per year to cover the expected total costs<sup>20</sup>, however, investment over such a long period of time cannot be calculated with a high reliability, so the expert report from 2015 sees a 25% chance that this amount may not be reached.

**Total cost estimate for spent fuel disposal:** The EC reported in 2019: *“Given that today there is no disposal route available for spent fuel (first disposal facilities to become operational in 2024-2035) and that not all Member States have their spent fuel reprocessed, there is a continual increase in the amount of spent fuel in storage (...)”* (EC Report 2019a, p. 25)

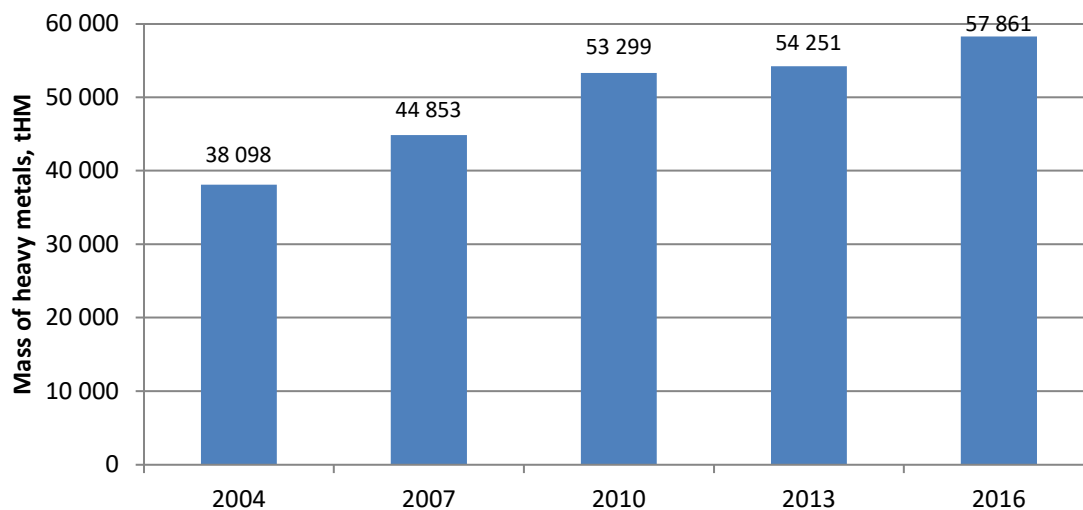


Figure 3: Evolution of spent fuel mass in storage in Member States since the end of 2004 (EC Report 2019a)

**In 2030**, this amount is estimated to rise to **76,000 tHM** (EC Report 2019a, p. 27) When multiplying this with the estimated costs for Onkalo, **a total sum of 58.5 bn euros will be needed only for DGRs** (assuming that they do not cost more than the Finnish DGR).

And this is not the end of it: Operation times for many NPP exceed 2030, future additional costs will arise.

<sup>19</sup> <https://www.kenfo.de/start>

<sup>20</sup> <https://www.stuttgarter-nachrichten.de/inhalt.energie-wende-stiftung-verdient-geld-fuer-den-atom-ausstieg.5e9bb036-3ea0-431e-a4ce-3c11f5a03efa.html>

## 10 Conclusions

Introducing the Nuclear Waste Directive has certainly been a step forward. It forced many member states to stop postponing their nuclear waste management and make their plans or lack of plans public. However, the implementation of the Nuclear Waste Directive is insufficient. The high number of infringement procedures shows that states chose to ignore their obligations in this field.

At the same time some of the Nuclear Waste Directive's articles and provisions allow for loopholes. To ensure a reliable legal framework, the Nuclear Waste Directive will need to be amended soon.

**We therefore ask EC to inform the public regularly on progress of negotiations with the member states about lacking and inadequately provided information.**

- Transparency is not satisfactory – **we ask EC to publish all (updated) national programmes and national reports without delay and inform about reasons for infringement procedures in more detail.**
- Discussions regarding multinational repository solutions and the status of their preparation need to be opened up to transparency and public participation.
- A Strategic Environmental Assessment (SEA) is the most effective means of public participation because it is comprehensive and legally binding. But in many countries the SEA for the national nuclear waste programme is still pending or not foreseen at all. The European Commission should ask EU Member States to subject their national programmes to **SEAs**.
- The provision of Article 10 (2) on public participation (*...that the public be given the necessary opportunities to participate effectively in the **decision-making** process regarding spent fuel...*) needs to be enforced in all EU member states.
- Member states need to identify timeframes, milestones and key performance indicators for their national programmes and report regularly on progress made.
- **We ask the EC to initiate the introduction of more effective consequences of non-compliance**, to ensure that the national programmes and the directive are properly implemented.
- It is necessary that **strict guidelines are introduced to include all types of radioactive waste incl. NORM, waste from decommissioning and planned new nuclear power plants**. Waste generation forecasts need to be precise and transparent. The scope of the directive should include military waste.
- **Legacies of nuclear waste** that has been dumped into the Sea and nuclear waste that has been **exported to third countries under agreements and are not covered** by the Waste Directive should be included. Not dealing with these topics will undermine a key principle of the Waste Directive that every member states is ultimately responsible for its nuclear waste – which should include all legacies and former exports.
- The **multinational disposal solutions** which are favoured by some member states and the EC need to undergo a reality check. They are highly unrealistic solutions and unless concrete projects are presented, they shouldn't be accepted as a solution under the radioactive waste management Directive. Until now, no member state has stepped forward to volunteer a site in its country (legally not even possible due to waste important bans and severe liability issues) It is therefore essential that **every member state also develops a national final disposal instead of relying solely on a vague multinational solution.**

Data on costs and financing have to be provided for every phase in the waste management programme, including decommissioning, new build, research reactors and institutional waste and of course also costs for the past-closure period. The Directive should include **strict guidelines for the necessary data and methods to be applied for defining them and the EC should require member states to submit all data within stringent timelines.**

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## 12 Annex 1: Key principles of Nuclear Waste Directive 2011/70/Euratom

The Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, adopted by the Council of the European Union on 19 July 2011, provides binding legal force to the main internationally endorsed principles and requirements in this field.

It introduced following key principles:

The Directive aims at ensuring a **high level of safety, avoiding undue burdens on future generations** and enhancing **transparency**; it reaffirms the **ultimate responsibility of Member States** for management of the spent fuel and radioactive waste generated in them, but also that prime responsibility for the safety of spent fuel and radioactive waste management lies with the licence holder under the supervision of its national competent regulatory authority. Each Member State remains free to define its nuclear fuel cycle policy. Member States are obliged to establish and **implement national programmes** for management of spent fuel and/or radioactive waste **from generation to disposal**. Member States are obliged to **notify** to the Commission their **national programmes** by August 2015 and any **subsequent significant changes**.

Member States are obliged to ensure that **necessary information** on the management of spent fuel and radioactive waste is made available **to the general public, and that the public is given the necessary opportunities to participate effectively in the decision-making process regarding spent fuel and radioactive waste management in accordance with national legislation and international obligations**.

Member States are obliged periodically, and at least every 10 years, to invite international peer reviews of their national framework, competent regulatory authority and/or national programme with the aim of ensuring high safety standards. The outcomes of the peer reviews shall be reported to the Commission and the other Member States. Member States are obliged to regularly review and update their national programmes, taking into account technical and scientific progress as appropriate as well as recommendations, lessons learned and good practices from **peer reviews**.

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