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REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT

on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects

SECOND REPORT

{SWD(2019) 435 final} - {SWD(2019) 436 final}

1 INTRODUCTION 3
2 RADIOACTIVE WASTE AND SPENT FUEL IN THE EUROPEAN UNION 3
2.1 Inventory estimates and trends 4
2.2 Future prospects 7
2.3 Challenges ahead 8
3 ENSURING SAFE AND RESPONSIBLE MANAGEMENT OF SPENT FUEL AND RADIOACTIVE WASTE 10
3.1 Transposition of the Directive into the national law 10
3.2 National frameworks 10
3.3 Competent regulatory authorities 11
3.4 Licence holders 11
3.5 Expertise and skills 12
3.6 Financial resources 12
3.7 Transparency 13
3.8 National programmes 14
3.9 Self-assessment and international peer reviews 16
4 CONCLUSIONS 17

1 INTRODUCTION

Under Article 14(2) of Council Directive 2011/70/Euratom[1] on the responsible and safe management of spent fuel[2] and radioactive waste[3] (hereinafter 'the Directive') the Commission is required to submit to the European Parliament and Council, every three years, a progress report on the implementation of this Directive and an inventory of radioactive waste and spent fuel present in the Community's territory, with a view to future developments.

In 2017 the Commission presented for the first time to the European Union (EU) citizens a comprehensive overview of the situation[4], which covered a reporting period until August 2015 with a reference date of December 2013. The present second report of the Commission provides an update of progress accomplished by Member States in implementing the Directive, in particular on the measures put in place to ensure that workers and the general public are protected against dangers arising from ionising radiation now and in the future, through the highest safety standards for radioactive waste and spent fuel management, and to avoid imposing undue burdens on future generations.

This report is based on the Member States' national reports which had to be submitted to the Commission by 23 August 2018 as per Article 14(1) of the Directive[5]. It addresses the overall EU inventory of radioactive waste and spent fuel (section 2), Member State compliance with the key aspects of the Directive (section 3) and sets out the Commission's conclusion (section 4).

The report is accompanied by two Staff Working Documents: one presenting the EU inventory of radioactive waste and spent fuel and its future prospects, with a reference date of December 2016 and the other presenting the overall situation on spent fuel and radioactive waste management in the EU based on national reports' analysis by the Commission.

2 RADIOACTIVE WASTE AND SPENT FUEL IN THE EUROPEAN UNION

All Member States generate radioactive waste through various activities ranging from medical applications to electricity generation. 21 Member States also manage spent nuclear fuel on their territory. Owing to its radiological properties and the potential hazard it poses to workers, the general public, and the environment, the safe management of such material from

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1 Council Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, OJ L 199, 2.8.2011, p. 48–56.

2 Spent fuel is "nuclear fuel that has been irradiated in and permanently removed from a reactor core" (Article 3(11) of the Directive) and that is no longer usable in its present form. It is generated by the operation of nuclear reactors for power generation, research, training and demonstration.

3 Radioactive waste is "radioactive material in gaseous, liquid or solid form for which no further use is foreseen or considered" (Article 3(7) of the Directive) and which has been classified as radioactive waste. Its generation is associated with the production of electricity in nuclear power plants or with non-power-related uses of radioactive materials for medical, research, industrial and agricultural purposes. Please see SWD(2019) 436 on Progress of Implementation of Council Directive 2011/70/Euratom for the definitions of others important concepts as provided by the Directive, such as storage or disposal.

4 Report from the Commission to the Council and the European Parliament on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects, 15 May 2017, COM(2017) 236 final, and corresponding SWD(2017) 159 final and SWD(2017) 161 final.

5 The analysis presented in the report is based on the national reports and the newly adopted or updated national programmes as submitted by Member States by March 2019.

generation to disposal must be ensured. This requires containment and isolation from humans and the living environment over a long period of time.

Most of the radioactive waste originates from nuclear power plants and associated nuclear fuel cycle activities. Smaller volumes of radioactive waste are generated as a result of non-power uses of radioactive materials, such as the manufacturing of radioisotopes for use in medical and industrial applications, or research facilities such as laboratories and research reactors.

Each Member State defines its own electricity generation mix and as of the reporting date nuclear power plants are in operations in 14 countries[6]. Two other Member States, Lithuania and Italy, have terminated their nuclear power programmes and are decommissioning their nuclear installations. These 16 Member States[7] with nuclear power programmes together account for 99.7% in volume of the radioactive waste inventory in the EU.

At the time of reporting, 126 nuclear power reactors were in operation, with a total capacity of about 119 GWe, 90 nuclear power reactors were shut-down, and 3 were decommissioned. In addition, there were 82 research reactors in 19 Member States either in operation, long-term shutdown, or under decommissioning[8]. Spent fuel and radioactive waste will therefore continue to be generated in the future, requiring their safe and long term management until disposal.

Under the Directive's requirements the Commission provides periodically a transparent and comprehensive overview of the Union-wide inventories of spent fuel and radioactive waste, including future prospects. This is key information to see whether Member States have taken reasonable steps in their national policies and programmes to avoid any undue burden on future generations for the management of spent fuel and radioactive waste.

2.1 Inventory estimates and trends

In the previous reporting cycle, the Commission emphasised the importance of developing a comprehensive and up-to-date inventory as a basis for Member States to set out an adequate national programming, cost estimation and related concepts and plans for the safe and responsible management of spent fuel and radioactive waste. To support Member States in this area, the Commission services collaborate with the International Atomic Energy Agency (IAEA) and the OECD's Nuclear Energy Agency (NEA) on defining a harmonised set of data on reporting of national inventories and is supporting the development of an IAEA harmonised reporting tool. The Commission is also carrying out a study on benchmarking of national inventories[9] to identify common aspects with respect to waste classification, best practices and challenges with respect to the collection, management of data as well as estimation of current and future inventories, including identification and treatment of uncertainties.

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6 Belgium, Bulgaria, Czechia, Finland, France, Germany, Hungary, the Netherlands, Romania, Slovak Republic, Slovenia, Spain, Sweden, and the UK. In addition, although it has no nuclear power plant within its own national borders, Croatia co-owns the Krsko nuclear power plant with Slovenia.

7 For the purposes of this report, those Member States that have nuclear power reactors on their territory either operational or shut-down are indicated as Member States with a nuclear power programme.

8 See the IAEA Research Reactor Database: https://nucleus.iaea.org/RRDB/RR/ReactorSearch.aspx.

9 Benchmark Analysis of Member States Approaches to Definition of National Inventories for Radioactive Waste and Spent Fuel (2017-156) (ENER/D2/2017-156).

In this reporting cycle the Commission has observed improved quality of inventory data, particularly in forecasts for future generation of waste. One third of the Member States (mainly those with nuclear programmes) provided detailed inventory information. However, most of the remaining Member States reported in the same format as in the first reporting cycle and their inventory reports were incomplete.

Based on lessons learned in 2017[4] more than two thirds of Member States have reported their radioactive waste inventory using the classification scheme as per the IAEA standard GSG-1[10] or provided matrixes enabling conversion of data from their national classification scheme into the IAEA standard. Further improvement is possible if all Member States adopted a similar approach.

The estimated total inventory of radioactive waste on the EU territory at the end of 2016 was **3 466 000 m^3** (4.6 % increase over three years), corresponding to an average of about 7 liters per-capita in the EU[11]. 71.6% of this volume has been disposed of (7% increase over three years). Thus, in those Member States where disposal routes are open for very-low-level and low-level waste, the process from generation to disposal appears generally flowing. On average the amount of the radioactive waste in storage (983 000 m^3) did not significantly change in comparison to 2013. See Boxes 1-3 below for more details.

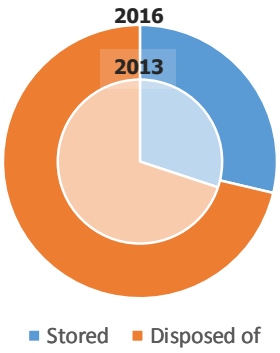
[10] 'Classification of Radioactive Waste', General Safety Guide, IAEA, Vienna, 2009.

[11] The highest per-capita value is registered in Lithuania at about 31 liters.

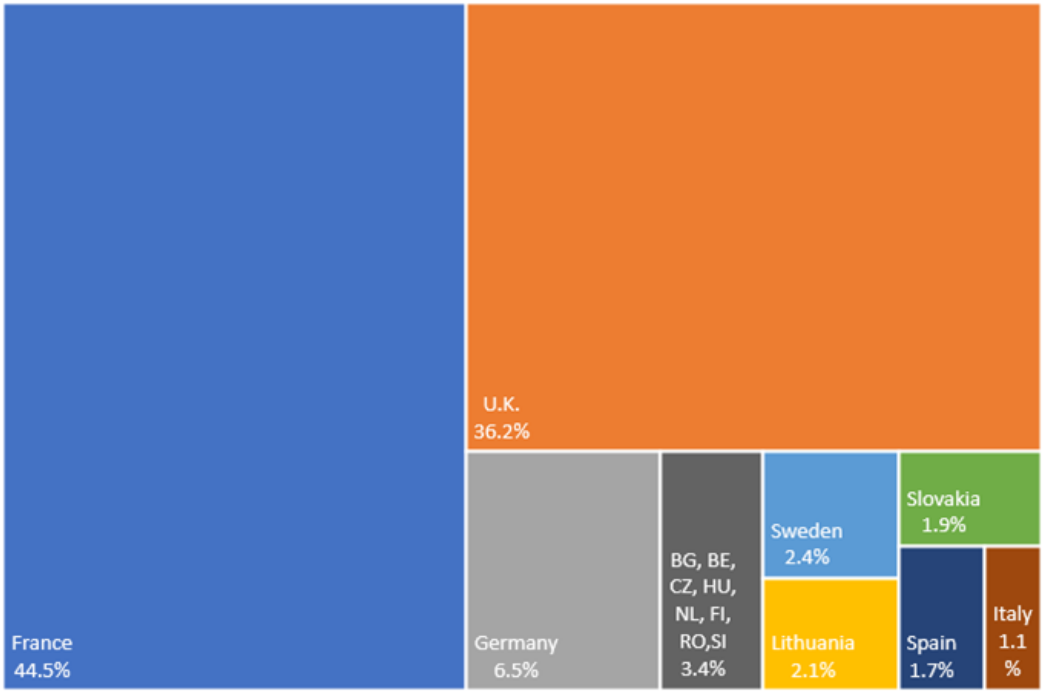
Box 1

Volumes and status of radioactive waste in the European Union, end of 2013 and 2016.

Amounts (thousands m^3)						
	Stored		Disposed of		Total	
Year	2013	2016	2013	2016	2013	2016
VLLW	237	234	279	369	516	603
LLW	428	417	2 025	2 102	2 453	2 519
ILW	326	326	12	12	338	338
HLW	6	6	0	0	6	6
Total	**997**	**983**	**2 316**	**2 483**	**3 313**	**3 466**

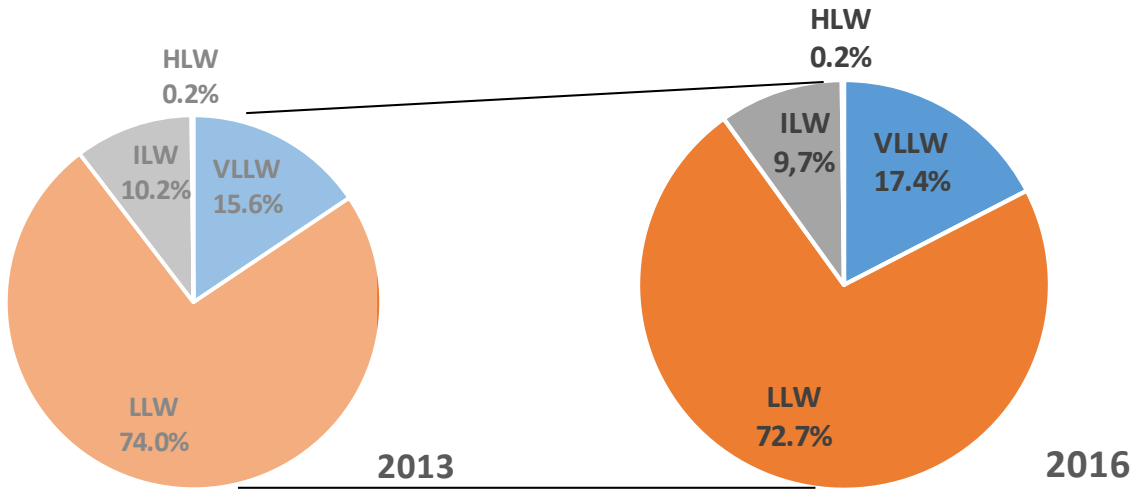


Distribution of total volumes of radioactive waste in Member States with a nuclear power programme, end of 2016.



Distribution of radioactive waste by class has not changed significantly compared to 2013 with very-low-level and low-level waste representing 90%. Low-level waste dominates EU radioactive waste inventory, noting two specific points for consideration: i) some Member States classify very-low-level and low-level waste in the same category in their national classification system; and ii) some other Member States register partially or do not register the very-low-level waste in their national inventories.

***Box 2** - Distribution of radioactive waste per category.*



Intermediate-level waste and high-level waste are generated and stored predominantly in the Member States with nuclear power programmes. At the end of 2016[12] approximately **58 000 tHM of spent fuel was stored in the EU**, (7% increase over three years). About 1.5% of this spent fuel was stored in the Russian Federation pending reprocessing with the expected resulting material to be returned to the EU after 2024.

All spent fuel present in the EU is currently in storage, as no civil disposal facility for spent fuel is in operation worldwide. The majority of Member States operating nuclear power plants intend to dispose of their spent fuel in deep geological facilities without reprocessing, although two Member States[13] are considering future reprocessing abroad. With the termination of reprocessing activities in 2018 at THORP[14] and the planned ceasing of reprocessing of spent fuel in the UK by 2020, France will be the only Member State with an industrial policy on reprocessing spent fuel domestically.

2.2 Future prospects

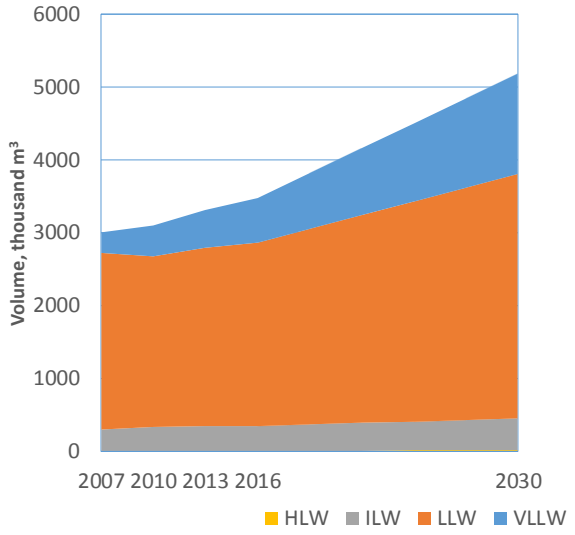
Based on the new inventory data, the Commission is in a position to present for the first time the future prospects of EU radioactive waste and spent fuel inventory by 2030.

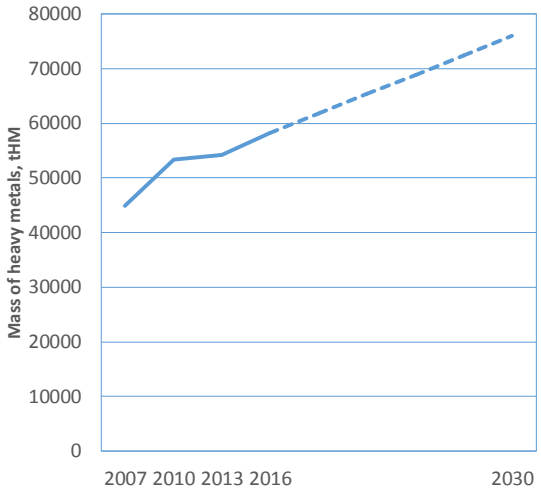
12 The cut-off date for most data is end 2016 in order to reduce reporting burden on the Member States and facilitate joint reporting with the Joint Convention. A few Member States have provided more recent figures (i.e. end of 2017). Please see SWD on inventory for details.

13 Czechia and Hungary.

14 The Thermal Oxide Reprocessing Plant, or THORP, is a nuclear fuel reprocessing plant at Sellafield in the UK.

Box 3 *- Evolution of radioactive waste (left) and spent fuel (right) inventories.*





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.

It is expected that due to the planned shutdown and decommissioning of a number of nuclear facilities the amount of waste will increase significantly during the next decade. By 2030 very-low-level waste amounts are expected to double, while the other waste classes are expected to increase by 20-50%. Therefore, attention should be paid to the minimisation of radioactive waste at the origin, development and implementation of predisposal options to reduce waste volumes and the development of new storage or disposal facilities.

2.3 Challenges ahead

Disposal of very-low-level waste and low-level waste

As reported in 2017 routes for disposal of very-low-level waste and low-level waste are open in most Member States with nuclear power plants. While progress is noted in development of new disposal facilities in the same group of Member States[15], others still have to develop concrete disposal plans. In addition, a few Member States reported delays in the commissioning of planned near surface facilities.

Overall, the situation of very-low-level waste and low-level waste disposal remains unchanged since the last report, with over 30 operational disposal facilities in 12 Member States. About half of the Member States are planning to build new disposal facilities[16] in the

[15] E.g. construction of new facilities in Bulgaria and Lithuania, and extension of existing facilities in Spain and Slovak Republic.

[16] See Table 8 of SWD(2019) 436 on Progress of Implementation of Council Directive 2011/70/Euratom.

next decade. The remaining Member States do not have concrete plans.

In view of the above and of the expected increase of waste volumes for decommissioning activities[17], development and implementation of predisposal processes to reduce waste volumes is becoming increasingly important. The Commission encourages Member States to implement waste reduction and optimisation measures, and to report on the concrete plans for disposal of all radioactive waste, including decommissioning waste, institutional waste, and other waste from remediation activities.

Disposal of intermediate-level waste, high-level waste and spent fuel

The main challenges identified by the Commission in 2017 were related to the lack of concrete disposal concepts and plans for intermediate-level waste, high-level waste and spent fuel in most Member States, often due to the need for policy decisions to be made or sites to be selected.[18] In spite of the adoption or update of national programmes during the last three years, no significant progress was observed overall in this respect.

All Member States with nuclear power programmes except one[19] have plans to develop geological disposal facilities. Of these 15 Member States, only Finland, France and Sweden have demonstrated concrete steps towards practical implementation. These 3 Member States are amongst the most advanced in the world. Globally, Finland[20] is the first country where the construction of a deep geological facility has begun and is expected to be in operation by 2024. It will be followed by Sweden in 2032 and France in 2035. In all cases a few years' delay are noted in comparison to 2017. The remaining 12 Member States also have plans for a deep geological repository. They are at different stages of implementation between 2040s and 2100s, however only a few of them reported progress in site selection.

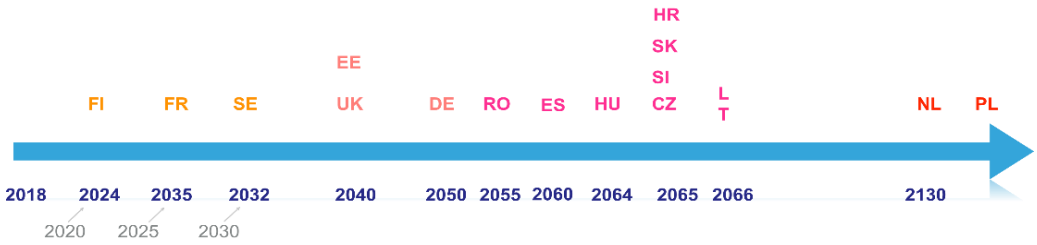


Figure 1. Planned start of operation of deep geological facilities

The engagement of Member States needs to increase in developing long-term management solutions for intermediate-level waste, high-level waste, and spent fuel, including research, development and demonstration activities as soon as possible to avoid placing an undue

17 See Table 2 of SWD(2019) 436 on Progress of Implementation of Council Directive 2011/70/Euratom.

18 See Table 7 of SWD(2017) 159 on Progress of Implementation of Council Directive 2011/70/Euratom.

19 The Commission has referred this Member State to the Court of Justice of the EU, which delivered its judgment on 11 July 2019 (C-434/18), upholding the claims of the Commission. The judgment is available on the Court's website: http://curia.europa.eu/juris/document/document.jsf?text=&docid=216079&pageIndex=0&doclang=FR&mode=lst&dir=&occ=first&part=1&cid=1798248

20 Finland is also the first country in the world that is currently planning to develop a second geological disposal facility to ensure safe disposal of the high-level waste and intermediate-level waste from the new build reactors by Fennovoima.

burden on future generations. All necessary measures should be taken in order to ensure at policy and technical level that no excessive delays in project implementation are encountered in the future. As such, all Member States should optimise planning, commit adequate resources, perform the necessary research and training activities and engage with the public and other stakeholders in order to accelerate implementation.

3 ENSURING SAFE AND RESPONSIBLE MANAGEMENT OF SPENT FUEL AND RADIOACTIVE WASTE

3.1 Transposition of the Directive into the national law

Member States were required to incorporate the Directive into their national legal framework by 23 August 2013. To date the Commission received transposition measures from all Member States and closed all open infringement procedures for non-communication of measures transposing the Directive[21].

On the substance of the transposing measures, in 2018 the Commission concluded that more than half of the Member States had not correctly transposed the Directive's provisions and thus started infringement procedures against 15 Member States[22]. The main issues encountered concern the requirements on: financial resources (Article 9) for almost half of Member States, safety demonstrations of facilities or activities (Article 7(3)), expertise and skills (Article 8) and definitions (Article 3). For one third of the Member States the Commission has assessed as not adequate the provisions requiring effective independence and sufficient legal powers, financial and human resources of the competent national authorities (Article 6(2) and (3)).

3.2 National frameworks

Overall, since the first reporting cycle, most Member States have made significant efforts to improve their national framework and implement the Directive. This has been done mainly through adoption of new legislation, improvement of organisational arrangements, self-assessments, international peer-review results and corresponding actions as a response to the Commission assessments.

In Member States with a nuclear power programme national frameworks are generally comprehensive and more developed in comparison with other countries. About half of the other countries have progressed well in setting out an adequate national framework. The rest faces challenges related to (i) decision on a long-term solution for management of radioactive waste and spent fuel; (ii) decision on new nuclear power generation, or (iii) revision of legislation[23].

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21 In November 2013, the Commission had sent letters of formal notice to 13 Member States for non-communication of national measures transposing the Directive. Out of four opened non-communication cases in 2016, three (Austria, Germany, and France) were closed within one year and the last one in January 2018.

22 Austria, Czechia, Denmark, Estonia, Croatia, Hungary, Ireland, Italy, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, and the UK. The cases against Czechia and Ireland were closed in July 2019.

23 E.g. due to the transposition of another directive such as Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom,

Significant organisational changes have occurred in two Member States[24] related to the roles and responsibilities of radioactive waste management organisations, and in a few Member States changes occurred related to the competent national authorities.

3.3 Competent regulatory authorities

In 2017 the Commission concluded that all Member States have one or more competent regulatory authorities, in line with Article 6(1) of the Directive.

In the current reporting period a few Member States[25] introduced changes to their competent regulatory authorities aimed at creation of new authorities, reorganisation, consolidation of functions and other Member States are planning to introduce changes soon[26].

The Commission has engaged with several Member States to clarify, demonstrate or achieve functional independence of the competent regulatory authority. In this regard, there is a need for some Member States to report on the roles and responsibilities of local/regional competent authorities dealing with radioactive waste management.

The majority of Member States have mechanisms to retain skilled staff within the regulatory authorities. On the other hand, a few Member States acknowledged lack of human resources.

Half of the Member States reported on the financial resources available to their competent regulatory authorities. As Member States in some cases provide more information in their Joint Convention[27] report, the Commission encourages those to make use of the latter and submit the relevant information under Article 14(1) of the Directive, as required. In general, more detailed information is needed in the next reporting cycle.

3.4 Licence holders

As in the previous reporting cycle, all Member States have reported legal requirements to ensure that the primary responsibility for spent fuel and radioactive waste management rests with license holders[28].

A challenge for half of the Member States was the transposition of the requirement for regular assessment, verification and continuous improvement of safety of facilities or activities in a systematic and verifiable manner. The majority of Member States reported the status of safety assessments activities, the latest or planned safety demonstrations as part of the licensing processes, and on the application of integrated management systems or quality assurance. One third has yet to report on how these requirements are implemented in practice. Two Member States have amended their legislation to address integrated management system, while a few Member States have not addressed the management system in their reports.

Overall, Member States have established legal requirements on licence holders to provide for and maintain adequate financial and human resources, except for five countries for which the

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96/29/Euratom, 97/43/Euratom and 2003/122/Euratom, OJ L 13, 17.1.2014, p. 1–73.

24 Lithuania and Germany.

25 Germany, Italy, Malta, The Netherlands, Portugal and the UK.

26 Austria and Belgium.

27 Joint Convention on the Safety of Spent Fuel management and on the Safety of Radioactive Waste Management.

28 Article 7 of the Directive.

infringement procedures were launched in 2018. An adequate assessment of the status of financial and human resources of license holders is difficult due to the limited information provided by Member States in their national reports (less than a third reported this information). As a good example, a few Member States addressed provisions and measures in case of bankruptcy to ensure long-term safe management of spent fuel and radioactive waste. The Commission encourages Member States to provide further details on these matters in the next reporting cycle.

3.5 Expertise and skills

The majority of Member States have legal requirements in place to ensure the training and education of staff of all parties involved, however in 2018 the Commission required a third of Member States to improve the legislation in line with Article 8 of the Directive.

Overall, development and maintenance of expertise and skills is better defined and reported for regulatory authorities than for other stakeholders and licensees. Member States with nuclear power programmes have in general more developed formal arrangements for education and training, including research, while this aspect remains a challenge for other countries.

Research and development activities are well covered by one third of the Member States, all being countries with nuclear power programmes. All countries without nuclear power programmes have difficulties in covering the research and development requirements of the Directive. This is an aspect that needs to be improved in the future.

3.6 Financial resources

In 2017 the Commission presented for the first time a comprehensive EU overview of the total cost for radioactive waste and spent fuel management. In order to be able to conclude on the accuracy and completeness of cost estimates, the Commission concluded that national programmes should be revised to include more information. Therefore, it urged Member States to fully comply with the requirements of the Directive related to cost assessments (Article 12(1)(h)) and to financing mechanisms (Article 12(1)(h) and Article 9).

Based on the updated data from about a third of Member States, the new estimate of the total cost of the management of spent fuel and radioactive waste in the EU is in the range of EUR 422 - 566 billion[29,30], compared to EUR 400 billion of the previous report. Taking into account the ongoing re-evaluation of costs and planned revision of a number of national programmes (about a third) in the near future, these estimates are expected to change. Until the timing of the costs is clearer in all Member States, allowing for a time value adjustment of the costs, these figures should be taken as preliminary. In any case, this cost is a fraction (<10%) of the unit price for electricity produced from nuclear power plants in the EU.

About half of the Member States provided information about the status of the funds for spent

[29] The upper boundary is mainly driven by the UK estimate of the undiscounted cost scenarios of the Nuclear Decommissioning Authority.

[30] See detail per Member State in the SWD(2019) 436 on Progress of Implementation of Council Directive 2011/70/Euratom. Information from ongoing infringement procedures has however not been included.

fuel and/or radioactive waste management although with different levels of detail[31]. The Commission notes that a number of Member States declared insufficiency of funds to date, while two[32] expressly rely on EU funding.

In view of the ongoing revision of the cost estimates in most Member States and the need for building confidence in the results, Member States need to provide a complete assessment of the national programme costs describing the underlying basis and hypotheses for that assessment, including a profile over time. This should include all steps of the radioactive waste and spent fuel management covered by private generators and state budget. The Commission deems that further information and analysis are required.

The Commission, through the Decommissioning Funding Group and collaboration with international organisations, works[33] to improve the understanding of financial issues related to nuclear decommissioning and management of spent fuel and radioactive waste. This also includes cost estimation methods.

3.7 Transparency

In 2017, the Commission encouraged Member States to report on the mechanisms in place to ensure public participation in the decision-making process beyond public consultation, such as working groups, advisory bodies or national committees. To date all national reports and notified national programmes provide detailed information on the policy and legal framework regulating the transparency arrangements. Member States inform the public via web sites, reports, media, etc. and consult the public and stakeholders via different mechanisms for public information. 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 general, countries with nuclear power programmes make use of a broader variety of techniques and channels of information. Some specific programmes, namely those concerning deep geological disposal, have led to the adoption of *ad hoc* communication strategies and the undertaking of great scale information campaigns. A few Member States emphasised the importance of promoting education of citizens to improve public understanding and acceptance of spent fuel and radioactive waste management, e.g. through student education systems.

The Commission stresses the importance of effective implementation of the transparency requirements of the Directive and the next reporting on progress of implementation in practice.

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31 See Table 10 in SWD(2019) 436.

32 Lithuania and Estonia.

33 This will build on the recent study carried out by the Commission on the Member States Cost Assessment and Financing mechanisms for Radioactive Waste and Spent Fuel Management with Regards to Council Directive 2011/70/Euratom (2017-160), ENER/D2/2016-471-1.

3.8 National programmes

The Directive sets out a key requirement for Member States to establish and maintain a national policy on safe and long-term management of spent fuel and radioactive waste. These policies shall abide by general principles[34] such as: ultimate responsibility of the Member State in which the spent fuel and radioactive waste are generated, minimisation of radioactive waste generation, proper consideration of interdependencies, safe long-term management based on passive safety features, graded approach, costs to be borne by waste generators, adequate funds available when needed, and evidence-based and documented decision-making processes for all stages of the management of spent fuel and radioactive waste. The policies should be translated into concrete plans of actions in each Member State national programme[35].

In 2017 the Commission concluded that most Member States had established ultimate responsibilities for spent fuel and radioactive waste management. However, only a third of the Member States had established comprehensive policies addressing all types of radioactive waste and spent fuel, as well as all stages of their management. The Commission followed this up by launching infringement procedures against the non-compliant Member States in 2018. Since then, about one third of the Member States reported on development of new or updated national policies.

To date, seven Member States that have opted for spent fuel reprocessing will receive radioactive waste after reprocessing (in the EU or outside) in the period 2018-2052. Two Member States[36] with a nuclear power programme have kept this option open until a decision is made. Most Member States also plan to return the spent fuel from research reactors in line with Article 4(3)(b) of the Directive to the supplier (i.e. USA and the Russian Federation) in the period 2019-2026 or if this will not be possible, to develop disposal solutions.

While a few countries consider the option of a shared solution for disposal, in particular for high-level waste and spent fuel, no significant development has been observed in practice in the last three years. The viability of this option is limited by a legal ban of import of radioactive waste in about half of the Member States[37].

The Commission notes significant progress with respect to the development and adoption of national programmes for spent fuel and radioactive waste since the first reporting cycle. To date all Member States notified their final national programmes, except Italy. Since the first Commission report in May 2017, five Member States[38] notified their new programmes and six notified their updates[39]. In 2018 the Commission referred three Member States to the Court of Justice of the EU (CJEU) for non-notification of their national programmes. While two of these cases were withdrawn by the Commission, following the notification by the Member

34 Article 4 of the Directive.
35 Articles 11 and 12 of the Directive.
36 Czechia and Hungary.
37 See Table 6 in SWD(2019) 436.
38 Czechia, Portugal, Latvia, Austria and Croatia.
39 France, Ireland, Estonia, Slovenia, Malta and Czechia.

States of their final programmes, the Court of Justice upheld the claims of the Commission on the case against Italy in a judgement delivered on 11 July 2019[40].

As mentioned above, the Commission urged 16 Member States in 2018 and one Member State at the beginning of 2019 to fully comply with the requirements of the Directive related to the national programmes[41,42]. The Commission concluded that most of them have not adequately addressed the assessment for the national programmes costs (Article 12(1)(h)). The other main challenges identified are: the setting of financing mechanisms ensuring sufficient funding for the national programme implementation (Articles 12(1)(i) and 5(1)(h)); the definition of adequate timeframes and milestones for the entire national programme, including disposal (Article 12(1)(b)); and the definition of key performance indicators for monitoring the implementation of the programme (Article 12(1)(g)).

Five Member States[43] plan to revise their national programmes by the end of 2019 in order to address non-compliance with the Directive identified by the Commission. With the six Member States that notified their updated programmes, this leads to updated programmes in more than one third of the Member States.

All Member States have developed concepts or plans, and technical solutions for the management of radioactive waste and spent fuel in the short term. This includes in general predisposal concepts up to, and including, interim storage. Disposal concepts, plans and technical solutions are in place for very-low-level waste and low-level waste. For high-level waste, as well as spent nuclear fuel, further efforts are necessary. In view of the long timespans foreseen for the disposal of spent fuel, Member States have put in place plans for long-term storage of spent fuel, mainly planning to or already using dry storage technology.

Monitoring progress towards implementation

Radioactive waste and spent fuel management is a long process and this is reflected in the programmes of 27 Member States that span until 2155.

In comparison with the adopted programmes, Member States with clear disposal programmes for all waste types reported slight delays, which currently do not affect the overall implementation of the national programmes. In addition, a few years' delay has also been reported by Member States with plans for siting and development of geological disposal facilities. This needs to be monitored to ensure that this delay does not result in a postponement of decisions and undue burdens to future generations. In case of further delay, Member States should evaluate the implications, including costs for their national programmes.

One of the main challenges identified for most Member States' programmes in 2017 was a clear definition and implementation of key performance indicators for monitoring progress

[40] Austria (C-487/18, case withdrawn in November 2018), Croatia (C-391/18, case withdrawn in March 2019) and Italy - C-434/18.

[41] Belgium, Bulgaria, Czechia, Germany, Denmark, Estonia, Greece, Malta, Spain, Ireland, Lithuania, The Netherlands, Poland, Romania, Slovenia and the UK in May 2018. Latvia in January 2019.

[42] To date all but one (Belgium) responses to the infringement procedure (letter of formal notice) were received.

[43] Bulgaria, Czechia, Greece, Poland and Romania.

towards implementation of the national programmes as required by Article 12(1)(g) of the Directive. These indicators are an important tool not fully exploited thus far.

The Commission concluded that over a third of the Member States have not defined key performance indicators in line with the Directive and thus called on these Member States to comply with the relevant requirements. The key performance indicators are used to conclusively, objectively and quantitatively measure progress towards set targets (for example the timely achievement of milestones). Well-designed key performance indicators increase transparency about performance related to national policy objectives, such as safety of the management of spent fuel and radioactive waste and the responsible use of financial resources.

Member States have to develop, implement and review key performance indicators, relevant for the scope and scale of their national programmes and report on the outcomes in more detail to the Commission in the next reporting cycle in 2021. The Commission services are planning to support Member States in addressing this challenge through a study in 2020[44], and building on the outcomes of the Commission workshop on the lessons learnt from the implementation of the Directive held in November 2017.

Research, development and demonstration activities

In 2017, the Commission emphasised that research, development and demonstration activities should be clearly related to activities, timeframes, concepts, plans, and milestones defined in the national programmes. It also encouraged Member States involved in European research initiatives to explain how these projects support in practical terms the implementation of their national programmes.

To date the overall situation on implementation of this provision remains the same - four Member States[45] operate five underground research laboratories for spent fuel, intermediate-level waste and high-level waste disposal and four[46] Member States plan to develop such laboratories in the 2020-2055 period[47]. The second national reports do not provide detailed information on research, development and demonstration activities to support solutions for safe long-term management of spent fuel and radioactive waste in Member States. One third of Member States, mainly those with large and medium sized nuclear programmes, provided details on their research programmes, and presented the progress made. Member States without spent fuel and with small amounts of radioactive waste do not develop specific research, development and demonstration programmes but mainly rely on international cooperation projects in line with their needs.

3.9 Self-assessment and international peer reviews

Many Member States reported that the IAEA international peer reviews IRRS (Integrated Regulatory Review Service) and ARTEMIS (Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation) are significant

44 Study on the Key performance indicators for monitoring implementation of national programmes on safe and long term management of spent fuel and radioactive waste (2019-209 V1.2).

45 Belgium, Finland, France and Sweden.

46 Czechia, Hungary, Poland and Romania (latter *as per* national programme).

47 Hungary reported scheduled operation in 2032.

contributors to the improvement of the national framework. In the reporting period 14 Member States[48] have organised IRRS and/or ARTEMIS missions.

Similar to the first reporting cycle most Member States have provided information on self-assessments and international peer reviews of the regulatory authorities (IRRS). To date all EU Member States have carried out or planned[49] IRRS review missions.

Member States progressed significantly in planning and carrying out self-assessments and peer reviews of the national programmes and/or national frameworks. Six Member States[50] have completed ARTEMIS review missions in 2017-2019 and four planned to carry them out by the end of 2019[51]. Most of the remaining (all except three) Member States have developed a schedule for inviting such peer reviews by August 2023. Those 3 Member States should put the necessary measures in place for a timely self-assessments and invitation of such reviews. In addition, although the IRRS and ARTEMIS reports are publicly available in most Member States, Member States need to notify the outcomes of such reviews and their plans to address recommendations and suggestions *as per* Article 14(3) of the Directive.

4 CONCLUSIONS

In the last three years Member States have made a number of steps towards demonstrating that they have been taking reasonable actions to ensure that no undue burden is passed to future generations and that radioactive waste and spent fuel is managed safely. Experience in decommissioning and waste management is progressively being gained, thus creating better conditions for setting effective policies to ensure safe and timely decommissioning and waste disposal. However, more needs to be done. This second reporting cycle has confirmed the Commission views presented to the Council and Parliament in 2017, as Member States need to further accelerate in addressing key challenges.

Primarily, the Commission encourages Member States, which have not yet done so, to take a swift decision on their policies, concepts and plans for the disposal of radioactive waste, in particular intermediate-level waste and high-level waste. Member States that consider shared solutions, should cluster up and take practical measures, including site-specific matters.

Another key challenge remains ensuring that adequate funds will be available for the costs of national programmes. In order to tackle it, Member States must improve the cost assessment, make estimations/decisions on their timing, and review both elements periodically and consistently with their national programme.

EU level action on radioactive waste classification schemes, criteria for pre-disposal management and qualification processes may help opening cross border collaboration between Member States on sharing technical and licensing practices on final disposal solutions and creating opportunities for the EU-wide market in equipment and services related to decommissioning and radioactive waste.

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48 Austria, Bulgaria, Belgium, Cyprus, Czechia, Estonia, France, Luxembourg, Hungary, Poland, Romania, Slovak Republic, Spain, and The Netherlands .

49 Latvia and Portugal.

50 Poland, France, Bulgaria, Luxembourg, Estonia and Spain.

51 Latvia, Germany, Estonia and Romania.

The Commission notes different stages of implementation of the national programmes. Several Member States reported a few years' delays in the implementation of programmes, including for the first geological disposal facilities. In most Member States, further work is needed in developing and implementing clear key performance indicators to monitor progress in effective and transparent ways, and to ensure timely accomplishments.

Furthermore, the inventory projections for the scope of the national programmes, including decommissioning waste, institutional waste and waste from remediation activities, and the demonstration of sufficient capacities for storage and disposal, should be improved.

The Commission notes that further work is needed by Member States to clarify, demonstrate or achieve functional independence of the competent regulatory authority. Some Member States need to establish also adequate provisions requiring sufficient financial and human resources of the competent national authorities.

The ongoing review and update of the national programmes taking into account the outcomes of self-assessments and international peer review results remain of high importance in building stakeholders' trust and confidence in the management of these materials in the EU. Significant steps towards conducting and planning the self-assessment and international peer reviews have been taken so that competent authorities, national frameworks and national programmes benefit from best practice and international safety standards in the field. The Commission encourages Member States to share outcomes of these reviews, engage in transparent dialogue with stakeholders, and facilitate the exchange of best practices and knowledge at EU level.

Research, development and training also remain important in delivering long-term solutions for high-level and intermediate-level waste and spent fuel management.

Many Member States need to improve the quality of their national reports, notified to the Commission. Information missing, or repeated from the previous reporting cycle, as well as listing the requirements instead of indicating progress "on the ground", do not give the Commission the necessary information to report at EU level.

To ensure full compliance with the requirements of the Directive related to the national legislations and national programmes, the Commission has initiated several infringement procedures against Member States in the past reporting cycle. It has also taken legal actions against three Member States for the non-notification of their national programmes, which led, for one of these cases, to a judgement of the Court of Justice upholding the claims of the Commission. The Commission will follow up these actions and pursue its work to support Member States in fully applying the Euratom legislation on responsible and safe management of spent fuel and radioactive waste.