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EVALUATION

Ex-ante Evaluation

Accompanying the document

Proposal for a Regulation of the Council

establishing the research and training programme of the European Atomic Energy Community for the period 2028-2032, complementing Horizon Europe, the Framework Programme for Research and Innovation, and providing for the Community's contribution to the ITER project, and repealing Regulation (Euratom) 2025/1304

{COM(2025) 594 final} - {SWD(2025) 595 final}

1. CONTEXT 3
2. PROBLEM ANALYSIS AND NEEDS ASSESSMENT 4
2.1. Underinvestment in nuclear research in the EU 5
2.2. Developing fusion as a viable energy source 6
2.3. Ensuring funding for ITER 9
2.4. Challenges for research and training in nuclear fission 10
2.5. Past experience, lessons learnt and going forward 17
2.5.1. EU added value 17
2.5.1. Findings from interim evaluation of 2021-2025 Euratom actions 20
3. OBJECTIVES FOR EURATOM PROGRAMME 2028-2032 23
3.1. General and specific objectives 23
3.2. Expected results of the programme 23
4. ALTERNATIVE DELIVERY MECHANISMS AND RISK ASSESSMENT 25
4.1. Option 1 – Business as usual for Euratom research and training (baseline scenario) 25
4.2. Option 2 – 'Enhanced Euratom programme supporting the development of safe and safeguarded innovative nuclear technologies for a prosperous and sustainable EU' 28
4.2.1. Fusion research 28
4.2.2. Euratom contribution to ITER 29
4.2.3. Fission research 30
5. PLANNING OF FUTURE MONITORING AND EVALUATION 33

1. CONTEXT

This ex-ante evaluation accompanies the Commission proposal for a Council regulation establishing the programme for research, training and ITER 2028-2032 (The 'Programme') of the European Atomic Energy Community ('Euratom) that provides funding for actions in nuclear fission and fusion as well as for the Euratom contribution to the ITER project.

The proposal for the Euratom programme is part of the package of Commission proposals for the next multi-annual financial framework covering 2028-2032. The MFF package aims at enhancing the competitiveness of the European Union as a critical priority. The EU must strengthen its research base to focus more on strategic priorities, on groundbreaking fundamental research, scientific excellence and disruptive innovation, while improving its productivity, connection with the market and stimulating growth[1].

The EU faces today several challenges, including energy dependence, the urgent need for decarbonisation and the imperative to maintain technological leadership and independence in a rapidly evolving global energy market and continuous geopolitical instability. Nuclear energy generates electricity in 12 of the 27 EU Member States and provided 22.8% of Europe's electricity and half of EU low carbon electricity in 2023[2]. The current role and potential of nuclear energy to meet the EU's climate goals, with co-benefits for air quality, and increasing electricity demand, as well as the promise of fusion energy and new nuclear technologies, including Small Modular Reactors (SMR) and Advanced Modular Reactors (AMR), place these technologies high on the EU's policy agenda. This is reflected in the Commission's strategic document and actions, such as the communication on Europe's 2040 climate target[3], which underlines the importance of all zero and low carbon energy solutions, including nuclear, to decarbonize the energy system. The 2024 report on "The future of European competitiveness"[4] ('Draghi report') further recognises that nuclear technology plays an enduring role in a competitive energy mix across the EU. It also considers nuclear fusion as 'a disruptive technology that holds the potential to revolutionise the energy landscape in the second half of this century'.

Nuclear energy is also included in recently adopted EU legislation, such as the EU's taxonomy on sustainable investments, intended to guide investments towards environmentally sustainable economic activities and the Net Zero Industrial Act, aimed at strengthening EU's manufacturing capacity for clean technologies.

With its legal basis in the Euratom Treaty, the Euratom research and training programme is the main EU programme funding nuclear research and training activities, including the ITER project, and supplementing Member States own research since 1958. In line with Article 1 of the Euratom Treaty, its task is to contribute to the raising of the standard of living in the Member States, one of the pillars of EU competitiveness as defined in the proposal for the European Competitiveness Fund. Therefore, the Euratom programme helps to further develop research in nuclear fission and fusion technologies, promoting innovation and capacity building while playing a key role in maintaining the highest standards of safety, security, safeguards and radiation protection in all applications of ionising radiation.

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1 SWD(2025)555
2 COM(2025)315
3 COM(2024)63
4 Report on "The future of European competitiveness", September 2024

Euratom is member of the ITER Organisation (IO), an international collaboration project between Euratom, United States, Japan, China, South Korea, India and Russia, implemented on the basis of the legally-binding international Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project (ITER Agreement)[5]. The ITER project aims at demonstrating the scientific and technological feasibility of fusion energy for peaceful purposes, an essential feature of which would be achieving sustained fusion power generation. Between 2007 and 2013, Euratom contribution to ITER was funded through the 7th Euratom Framework Programme[6]. Since 2014, the EU budget earmarked the contribution to ITER directly in the MFF Regulation (both for period 2014-2020[7] and 2021-2027[8]), which was then reflected in the Council Decision establishing Fusion for Energy[9].

In line with Better Regulation guidelines[10], this ex ante evaluation provides an analysis of key issues in nuclear field and for Euratom contribution to the ITER project, added value of EU actions in this field, policy objectives and associated risks. It was carried out by the Commission's services in Spring 2025, on the basis of interim evaluation of the Euratom research and training programme 2021-2025[11], interim evaluation study on implementation of Euratom contribution to ITER[12]. This analysis took also account of call for evidence for for above evaluations[13].

2. PROBLEM ANALYSIS AND NEEDS ASSESSMENT

Nuclear energy and ionising radiation technologies play an important role in the lives of all Europeans supporting security of energy supply and climate policies and provide essential solutions for healthcare (cancer treatment, medical imaging, etc.) and various industry sectors, in general improving competitiveness and innovation. These contributions are based to a large extent on the outcome of public and private research activities. Thus, nuclear science contributes to Europe's long term sustainable[14] prosperity and competitiveness.

The challenges the EU is facing – ensuring strategic autonomy, security of supply of affordable and low carbon energy, maintaining technological leadership and the risks linked to geopolitical instability – bring higher demands for nuclear research, as shown by recent developments in the nuclear research landscape and increased interest of many Member States in fission and

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5 ITER Agreement, OJ L 358, 16.12.2006, p. 62.

6 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=legissum:i23032

7 Art 16/2, COUNCIL REGULATION (EU, EURATOM) No 1311/2013 of 2 December 2013 laying down the multiannual financial framework for the years 2014-2020

8 Art 18/2, COUNCIL REGULATION (EU, Euratom) 2020/2093 of 17 December 2020 laying down the multiannual financial framework for the years 2021 to 2027

9 2007/198/Euratom: Council Decision of 27 March 2007 establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it; OJ L 90, 30.3.2007, p. 58–72

10 https://commission.europa.eu/law/law-making-process/better-regulation_en

11 COM(2025)61 and SWD(2025)54

12 External study: European Commission: Directorate-General for Energy, Pancotti, C., Catalano, G., Colnot, L., Banfi, S. et al., *Interim evaluation study of the implementation of the Council decision (Euratom) 2021/281 amending decision 2007/198/Euratom establishing the European joint undertaking for ITER and the development of fusion energy and conferring advantages upon it – Final report*, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2833/1515037

13 For more details see https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14112-Euratom-Research-and-Training-Programme-2021-2025-evaluation_en

14 Including the relevant UN Sustainable Development Goals such as SDG(7) Affordable and Clean Energy, and SDG(3) Good Health and Well-being.

fusion science and technology, for example with e.g. recent decisions Italy joining the European Nuclear Alliance in 2025[15]; Belgium repealing a 2003 law for the phase-out of nuclear power which banned the construction of new nuclear generating capacity[16]; and the Danish parliament approving an analysis of the potential use of nuclear, which has been banned for the past 40 years[17].

Systemic challenges to EU competitiveness, explained in the impact assessment accompanying the Commission proposal for the European Competitiveness fund and Horizon Europe Framework Programme also impact the nuclear field[18].

2.1. Underinvestment in nuclear research in the EU

Nuclear technologies are now seen as playing a more important role in the green transition while the opportunities it offers in other areas such as medicine are increasingly being appreciated. Comprehensive nuclear research is crucial for the EU to stay at the forefront of scientific and technological advancements. This includes improving and optimising current practices and launching new initiatives on nuclear systems, fuel cycles, safety, waste treatment and management, radiological understanding and medical and industrial applications of ionising radiation[19]. The EU needs to step up investment to remain abreast of technological developments and to protect the people and environment. The Euratom Scientific and Technical Committee[20] noted in its opinion that '*[It] is regrettable that the Euratom programme's funding for fission energy research has significantly decreased over the last decades, undermining expertise. [C]urrent resources do not align with the goal of fostering a new dynamic and fail to support the necessary research and education required to address the EU's energy transition and strategic autonomy challenges.*'

Against the background of wider geopolitical dynamics, an apparent shift towards economic protectionism seems to be occurring worldwide with consideration for strengthening competitiveness. International actors like the USA, the UK or South Korea have committed funding to bolster their nuclear sector, including through innovation with concrete ambitions for the development of future nuclear systems. Both Russia and China show strong interest for investing in emerging nuclear markets, particularly in Africa. On the other hand, Europe's

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15 Official Press release from MASE: L'Italia aderisce all'Alleanza UE sul nucleare - Ministero dell'Ambiente e della Sicurezza energetica

16 Bihet Law - https://www.dekamer.be/FLWB/PDF/56/0318/56K0318001.pdf

17 Denmark rethinking 40-year nuclear power ban amid Europe-wide shift | Denmark | The Guardian

18 Including: (1) *suboptimal support along the investment journey, from fundamental research, applied research through scale-up, industrial deployment, to manufacturing; (2) an innovation gap with other world regions; (3) a challenging geopolitical situation, with excessive strategic dependencies, and security and resilience issues; (4) high investment needs to deliver on EU priorities; and (5) a complex and uncoordinated EU funding landscape.* For more details see SWD(2025)555 and 556.

19 STC opinion 2024-36

20 The Euratom Scientific and Technical Committee (STC) is an advisory body established by the Euratom Treaty (Article 134). The members of the STC are appointed in a personal capacity by the Council of the European Union. The role of the STC is laid out in the provisions of the Euratom Treaty and includes the delivery of opinions on relevant scientific and technical issues, in particular in relation to the Euratom research and training programme.

investment in nuclear research and its subsequent role as a leader in research and innovation has been declining over the past decades[21]. This underinvestment in R&I lowers the capacity to prepare new markets for upcoming technologies with a supportive regulatory framework and R&D[22]. The global landscape is also marked by geopolitical tensions with heightened risks of nuclear proliferation and radiological emergency. The EU must increase its efforts towards nuclear R&I to preserve essential expertise and ensure the safe and secure use of nuclear technology for the benefit of EU's long-term security, strategic autonomy, resilience and competitiveness.

2.2. Developing fusion as a viable energy source

Nuclear fusion has the potential to bring significant long-term benefits to EU society especially in terms of energy self-sufficiency and varied energy mix. However, its very high development costs cannot be recuperated in full within the timelines typically expected in the private sector. There is a strong argument for using public and private funding to meet the costs of this research and doing so internationally, to the largest extent possible[23].

To ensure long-term EU competitiveness and global fusion leadership, Europe needs to continue pursuing fusion energy, which requires addressing important challenges such as global competition, key enabling technologies, workforce shortages, and fragmented approach to the regulation of fusion facilities in Europe[24]. These challenges must be overcome for fusion to contribute meaningfully to the sustained decarbonisation of the planet in the second part of the century, while ensuring Europe's security of supply.

The effective development and use of fusion energy in Europe relies on several main strands of action: (a) the successful completion and exploitation of the ITER project; (b) a steady support to research and innovation, in particular through the development on research and technology infrastructures; (c) a supportive framework for the development and competitiveness of European companies; and (d) coordinated governance in the EU[25].

Significant progress has been made in all these areas under the previous multiannual financial frameworks – but the challenges that remain, together with an acceleration of the context, call for stronger action.

The Draghi report underlines that nuclear fusion 'could play a pivotal role as a low-carbon, climate-friendly, affordable and safe energy solution based on an abundant and accessible

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[21] Tanarro Colodron, et al., Long-Term Horizon Scanning for Nuclear Technologies Yearly Report - 2023, Goulart, M., Casteleyn, K. and May, F. editor(s), Publications Office of the European Union, Luxembourg, 2024

[22] Report of the European Parliament on small modular reactors, ITRE Committee, 2023/2109(INI)

[23] IEA State of energy innovation report 2025

[24] European Commission: Directorate-General for Energy, GRS and KIT, *Study on the applicability of the regulatory framework for nuclear facilities to fusion facilities – Towards a specific regulatory framework for fusion facilities – Final report*, Publications Office of the European Union, 2021, https://data.europa.eu/doi/10.2833/787609

[25] European Commission: Directorate-General for Research and Innovation, *Fusion Expert Group opinion paper – Towards the EU fusion strategy*, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2777/3510421

supply of fuel material. The ITER project […] has propelled the EU to the forefront of global fusion research, investing billions of euros in the industry's supply chain and research. Despite notable progress in global fusion research, its practical deployment remains several decades away, necessitating further concerted effort and investment to bring this revolutionary energy source to market'. Therefore, for the EU, the investment in the ITER project - and in fusion in general - continues to be fully aligned with its priorities[26], which are to build a prosperous and competitive Europe capable to bolster its competitiveness and ensure its transition to a decarbonized economy.

Fusion energy research in Europe already benefits from a dedicated support under the Euratom programme, mainly materializing in the EUROfusion[27] initiative. EUROfusion has, since its creation in 2014, allowed leading academic organisations to fruitfully cooperate and advance the fusion research agenda, confirming the leading role of Europe in the field. Specifically, EUROfusion has made tangible progress since 2021 in its experimental campaigns and research, addressing the core missions of its roadmap[28] to develop fusion energy. Measured progress shows that EUROfusion delivers on its research milestones set in 2021, e.g. supporting mobility and access to research facilities and training a new generation of researchers and engineers. Key scientific achievements include, for instance, the engineering design and the safety report of IFMIF-DONES[29], and several plasma records as part of experimental campaigns[30]. Nevertheless, in the light of a fast-moving fusion landscape, with an increasing level of competition and private investments, there is a risk that EUROfusion (with its focus on academia) would alone not be sufficient to effectively support the European fusion industry base and, more generally, fusion-related innovation in the private sector. Another limitation of EUROfusion is its focus on magnetic confinement fusion – while this approach is considered as the most mature, alternative concepts (such as inertial confinement fusion) should also be further investigated.

More broadly, the current set-up for supporting the development of fusion energy in Europe remains significantly focused on research and science – insufficiently addressing the contribution of research to the development and competitiveness of European companies in the sector. The period that opens now is critical from this point of view: the level of private investments in innovative companies of the fusion sector has risen to unprecedented level, and

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26 https://european-union.europa.eu/priorities-and-actions/eu-priorities/european-union-priorities-2024-2029_en

27 Euratom grant of EUR 549 million (55% of total costs). For more details see https://euro-fusion.org/ and https://cordis.europa.eu/project/id/101052200

28 EUROfusion roadmap, see https://euro-fusion.org/eurofusion/roadmap/

29 International Fusion Materials Irradiation Facility and DEMO Oriented Neutron Source. Research infrastructure for testing, validation and qualification of the materials to be used in future fusion power plants, see https://ifmif-dones.es/

30 E.g., in 2023, EUROfusion's experimental campaign in JET produced 69 megajoules of fusion energy using deuterium-tritium fuel while sustaining fusion during a six second pulse, improving upon its record from 2021.

EU is (specifically, compared e.g. to the US[31]) lagging behind in this regard. The Union needs initiatives tailored to foster transfer of knowledge and technology from the labs to the private sector, leveraging academic achievements and effectively supporting the growth of start-ups and the consolidation of a European fusion energy supply chain. In addition, the Union needs to take the necessary steps to create the right conditions for, ultimately, the commercial development of fusion – including a sound regulatory framework.

Another challenge is the governance of the EU landscape of fusion initiatives, which remains fragmented and lacks strategic coordination. There is a growing consensus[32] according to which EU action should rely on the implementation of an overarching strategy to effectively address the remaining challenges towards commercial deployment of fusion energy, and specifically to ensure public-private synergies are fully exploited. The first EU Fusion strategy covering the period 2026-2034 is planned to be published by the Commission this year. The Euratom programme will be one of the main instruments to support its implementation, in particular by funding a public-private partnership to promote its commercialisation[33]. The need for EU strategy and for more substantial involvement of industrial and private sectors was also underlined by stakeholders participating in the public consultation on interim evaluation of the Euratom programme 2021-2025 (see box below)[34].

Box - Results of public consultation – respondents views on how to accelerate development of fusion energy in Europe:

1. The European Commission should **develop an EU Fusion Strategy** with a concrete short-term action plan and a comprehensive, long-term roadmap to advance fusion energy development and to establish the necessary ecosystem for the future commercialisation of fusion energy - 21% (42) of respondents agreed, 34% (67) strongly agreed, while 23% (45) did not know, 14% (27) were neutral, and 7% (14) disagreed or strongly disagreed.
2. The **industrial sectors and potential private investors' involvement is necessary** to accelerate the transition to commercial fusion energy - 28% (54) of respondents agreed, 34% (67) strongly agreed, while 21% (40) did not know, 10% (20) were neutral, and 7% (14) disagreed or strongly disagreed.
3. Resolving critical technological bottlenecks and demonstrating fusion technology to accelerate the development of enabling technologies will require a strong **partnership between the public and private sectors** - 27% (52) of respondents agreed, 32% (63) strongly agreed, while 22% (42) did not know, 14% (27) were neutral, and 6% (11) disagreed or strongly disagreed.

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[31] The EU's private ecosystem has eight companies and 70 investors and has raised €567 million up to 2025, representing 5% of the global funding while US accounts for 60%. (Source: https://www.euractiv.com/section/eet/interview/fusion-in-the-energy-grid-europe-needs-to-act-now/). An overview of private fusion industry is also provided in The Global Fusion Industry in 2025, Fusion Companies Survey by the Fusion Industry Association, 2025. Source: https://www.fusionindustryassociation.org/over-2-5-billion-invested-in-fusion-industry-in-past-year/

[32] Notably based on the feedback from relevant events, e.g. High-Level Roundtable on Fostering Innovation for Fusion Energy in Europe (March 2024) and 'EU blueprint for fusion energy' expert meeting (April 2024), and from a public consultation in 2024.

[33] https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en

[34] For details see SWD(2025)54

2.3. Ensuring funding for ITER

ITER remains an essential milestone of the path to demonstrating fusion energy in Europe. Its first results, engineering know-how and construction experience feedback will be fundamental in the design of a prototype fusion reactor that is expected to produce electricity. ITER is the only facility sized to provide the scientific and technical demonstration of fusion in a large volume of plasma with high fusion yield, while the future exploitation of ITER is also crucial for advancing the understanding of plasma physics and supporting the design of key components of future fusion power plants (e.g., tritium breeding module). Thus, ITER continues to play an important role in achieving industrialised fusion. While ITER construction has made considerable progress, the project had faced significant challenges, including delays and cost overruns, partly due to the first-of-a-kind character and complexity of the international collaboration involved.

To respond to the challenges, the new 2024 Baseline[35] (defining the scope, project cost, and schedule) introduced significant changes in the sequencing of the assembly of the ITER facility. The 2024 baseline is underpinned by a staged-approach for licensing, aiming at reducing risks. As a result, the revised timeline now foresees the "Start of Research Operation", with the first nuclear deuterium-deuterium (DD) operation in 2036. There is no delay compared to the previous 2016 schedule. The full fusion power in the deuterium-tritium (DT) phase is now expected in 2039 (with 4 years delay with respect to the previous schedule).

In the last two years the IO has achieved unprecedented performance in the rate of execution of the project. The IO reported in June 2025 that the current project activities were progressing in accordance with the schedule of the new baseline and that IO implemented most recent activities slightly below cost. Over the next MFF period, ITER requires steady support from the EU, and optimal coordination, to ensure construction is completed and exploitation can start according to the newly agreed baseline.

Funding for ITER is not only crucial for the completion of its construction in 2034, which will permit Europe to benefit of its investments, but also necessary for fulfilling the obligation of Euratom under the ITER Agreement. The contribution of each ITER Member is provided both in cash, through contributions to the budget of the IO for its functioning, and (mostly) in kind through the delivery of components of the ITER facility [36]. The ITER Agreement foresees that each ITER Member shall provide its contribution to the IO through a Domestic Agency , except where otherwise agreed by the ITER Council (the principal organ of the ITER Organization).

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[35] ITER Organization. (2024, June 20) *34th ITER Council Meeting: Updated baseline proposal presented to Council for further evaluation* [Press release]. https://www.iter.org/sites/default/files/media/2024_06_ic-34.pdf

[36] According to Art 8/2 of the ITER Agreement: *'The respective Members' contributions over the duration of this Agreement shall be as referred to in the documents "Value Estimates for ITER Phases of Construction, Operation, Deactivation and Decommissioning and Form of Party Contributions" and "Cost Sharing for all Phases of the ITER Project".'* EU as the Host Party bears 45.46% of the estimated costs for the Construction Phase, while each other ITER Member bears 9.09%. For the Operation Phase, EU bears 34% of the costs.

The approval of the ITER Council shall not be required for ITER Members to provide cash contributions directly to the IO.

The Euratom's Domestic Agency is the "European Joint Undertaking for ITER and the Development of Fusion Energy" (Fusion for Energy – F4E), which was established by the Council Decision 2007/198/Euratom in March 2007. F4E's budget originates 80% from the EU budget, while France as the ITER host country funds approximately 20%.

The unwavering commitment of the EU to ITER is an important signal to global partners in the evolving geopolitical context, to the EU industries delivering services and components to ITER, to the young generation considering a career in fusion, as well as to the EU citizens seeing that EU invests in potentially groundbreaking technologies of the future.

2.4. Challenges for research and training in nuclear fission

Homegrown, affordable and clean energy supports EU decarbonisation, competitiveness and resilience objectives, with co-benefits for air quality. Nuclear power plants supply clean power, suitable for low-carbon baseload electricity, also enhancing system integration and providing flexibility facilitating further roll-out of other clean technologies. These benefits accrue to the whole EU energy system. As noted in the last edition of the Commission's Nuclear Illustrative Programme (PINC)[37], some Member States are setting nuclear programmes extending operating life of existing reactors and announcing new builds. Finally, some are considering including nuclear in their energy mix for the first time.

Successful implementation of these plans requires mastering of the entire fuel cycle, fostering innovative start-ups ecosystems and conducting leading-hedge research, all while ensuring the highest standards of nuclear safety, security and safeguards, of safe and responsible management of radioactive waste and spent fuel, high-class education and training, as well as promoting transparency and public engagement[38].

The STC noted[39] that EU has lost its leadership position in nuclear fission, with a trend that correlates to the decrease in the current Euratom programme budget, which could negatively impact the ongoing operation and maintenance of existing nuclear facilities as well as the development of new facilities. Most new nuclear power plants worldwide are not based on European technology and in the developing field of SMR and AMR the most active players are outside Europe. The STC also notes that reestablishing this leadership is crucial for Europe's global influence and role in nuclear safety and in setting radiation protection standards, and that it requires investment and international cooperation. Reestablishing this leadership is crucial for Europe and the current resources do not align with the goal of fostering a new dynamic and fail to support the necessary research and education required to address the EU's energy transition and strategic autonomy challenges.

<u>Innovation gap for safe nuclear fission technologies</u>

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[37] COM(2025)215. See also https://energy.ec.europa.eu/topics/nuclear-energy/nuclear-investment-needs_en

[38] See footnote 27

[39] STC opinion 2024-36

Foreseen plans to extend the lifetime operation of existing nuclear power plants, coupled with an increasing number of new build projects in EU Member States, make nuclear safety and safeguards research essential to ensuring the continuous responsible use of nuclear technologies for current and advanced systems. It is also important to constantly improve safety standards by addressing issues common to different designs and technologies, such as ageing management, evaluation of safety margins, structural integrity assessment and evaluation of defect tolerance.

Renewed interest for nuclear energy production as a low-carbon alternative by some EU Member States has put the spotlight on SMR and AMR, envisioned to complement existing assets, support decarbonisation and contribute to EU's strategic autonomy. Third countries are competing to target EU Member States interest for deploying SMR technologies in their territories. This calls for a harmonized EU approach to safety, security and safeguards by design concepts that should be verified and validated independently. Further R&I is needed to demonstrate their safety features, including through advanced control systems and improved materials and fuel resilience[40].

Recent geopolitical shifts have also highlighted ongoing dependencies pointing out to a need for improving fuel cycle management and strengthening the security of supply to reinforce EU energy autonomy.

EU should also advance non-electric applications of nuclear technologies, including space exploration, marine propulsion, hydrogen production, district heating, and industrial uses. A substantial number of proposals submitted to Euratom calls in 201-2025 show potential for such innovative applications, which should be further developed during the next programme[41].

Sustainable nuclear skills and competences in the EU

In the face of many stakeholders concerned with potential shortages in qualified nuclear workforce, among others the members of the European Observatory on Human Resources for the Nuclear sector (EHRO-N) [42, 43] (which include industrial developers, research and technical safety organizations) maintaining adequate levels of nuclear skills and expertise in the EU is instrumental to ensuring continued independent activity in key areas of nuclear safety, security, safeguards, radiation protection, waste and spent fuel management, decommissioning, and non-power applications[44]. This is of strategic importance to safely manage existing technology, to guarantee the safety and safeguards assessment and deployment of advanced systems or to pursue innovation in non-power applications. New build nuclear projects in Europe also highlight the critical need for specific skills and point to the gaps in the current workforce at

[40] Draghi, M. (2024). The Future of European Competitiveness, Part B: In-depth analysis and recommendations
[41] See COM(2025)61
[42] https://joint-research-centre.ec.europa.eu/ehro-n_en
[43] For EHRON reports, see https://joint-research-centre.ec.europa.eu/ehro-n/documents_en
[44] Report on Human Resources needs in Research, Safety and Waste Management, ENEN2plus project, 2023 https://www.enen2plus.eu/fileadmin/user_upload/ENEN2plus_D1_2_20230531.pdf

national level, including amongst regulatory authorities and technical support organisations[45]. Political attention has grown stronger in a number of Member States for assessing the sectoral needs and qualification requirements of the nuclear workforce against the backdrop of a fragmented educational offer. Another challenge is the difficulty to attract, develop and retain new young talents to the nuclear sector.

Innovation gap for improving citizens' quality of life with medical applications and radiation protection.

Increasing attention is put on applications of nuclear science and the potential for innovative uses of ionising radiations in a variety of areas such as health, space, agriculture or the environment. In the medical field in particular, novel applications of ionising radiation and medical radionuclides, like the JRC-pioneered use of targeted alpha therapy using Ac-225[46], could benefit thousands of European patients facing cancer and other life-threatening diseases. All EU Member States have an interest in supporting medical applications of nuclear technology and furthering innovation research in the area. This is reflected in the Strategic Agenda for Medical Ionising Radiation Applications (SAMIRA)[47] adopted by the Commission in 2021. The Euratom programme and other research initiatives of the EU in the medical field coordinate with the implementation of SAMIRA in what regards innovation and the technological development of medical ionising radiation applications.

The field however faces several challenges. One relates to the supply of radioisotopes, with European production capacities mainly reliant on ageing research reactors, and the awaited completion of Pallas and the JHR early in the next decade[48]. Another important issue is ensuring radiation protection and the safe management of radioactive waste.

Concerning radiation protection, the focus remains in low-dose risk, efficient production of radioisotopes for medical purposes and radiobiological research**.** Understanding the health effects of radiation and improving protection measures are critical for public health and safety. This research is often underfunded by the private sector due to its non-commercial nature, requiring public investment to ensure that safety standards are based on the best available science. Evaluations indicate that a multidisciplinary approach in radiation protection research could be further encouraged to increase coverage of a broader spectrum of scientific questions, including questions related to planned, existing and emergency exposure situations. The research roadmaps prepared by Euratom initiatives CONCERT, PIANOFORE and EURAMED provide a sound basis for future state-of-the-art calls and should be systematically developed.

Radioactive waste and spent fuel management and geological disposal for the existing and future reactor fleet, as well as handling the decommissioning of nuclear facilities.

Continuous research and development, as well as demonstration activities are necessary to implement sustainable solutions for the safe and safeguarded management of spent fuel and

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45 OECD-NEA: https://www.oecd-nea.org/jcms/pl_21786/nuclear-education-skills-and-technology-nest-framework

46 Sathekge, Mike M et al., Actinium-225-PSMA radioligand therapy of metastatic castration-resistant prostate cancer (WARMTH Act): a multicentre, retrospective study, The Lancet Oncology, Volume 25, Issue 2, 175 - 183

47 SAMIRA Action Plan - European Commission

48 Tanarro Colodron, J. and Simola, K., Radioactive Isotopes, European Commission - Joint Research Centre, Petten, 2021

radioactive waste, ultimately contributing to increase confidence in the safety of disposal solutions and improve public acceptance of nuclear power.

The EU funded R&D work carried out during the 2000s and 2010s has confirmed that deep geological disposal is the most appropriate solution for long-term management of spent fuel, high-level waste and other long-lived radioactive waste. Given the progress achieved in radioactive waste management (particularly in the preparations of deep geological repositories in Finland as well as France and Sweden), research should now progressively depart from the acquisition of pure scientific knowledge to focus on the operation, safeguarding and oversight of deep geological facilities. European funded actions in this field should integrate this evolution by reinforcing the role of waste management organisations and technical safety organisations. The ethical basis for the strategic choices made in radioactive waste management and disposal should also deserve more attention. The research should address both extended interim storage and retrievability aspects, and the long-term corrosion behaviour after disposal in a geological repository. Research on remediation of non-conventional/accident sites involving degraded and molten fuel should address the optimization of damaged fuel management. In addition, the Euratom programme policy support should continue being provided to Member States and the European Commission to advice the development of national strategies for long-term storage and disposal of spent fuel and radioactive waste, and monitor compliance with Council Directive 2011/70/Euratom and the safeguards provisions in the new Commission Regulation 2025/974 Euratom.

Key role of nuclear research infrastructures

Nuclear research infrastructures are essential to the field of nuclear science and technology and constitute a founding principle of the European Research Area. They also play a key role in delivering and stimulating high-quality research and innovation. Data produced by experimental facilities is instrumental to understanding the behaviour of materials and components, develop new safeguards measurements and technologies and to assess safety systems, forming the building blocks of nuclear science and technology applications. However, managing and operating such nuclear infrastructure, requires continuous maintenance and upgrading to remain compliant with the obligatory provisions of safety and security under nuclear licenses and necessitates considerable allocation of resources, both specialised staff and of financial nature.

The sustainability of nuclear expertise strongly hinges on maintaining such facilities operational. European Commission's owned infrastructures play an integral role in advancing nuclear research and supporting the dissemination of knowledge through an offer of specialised training. Ensuring their availability and accessibility represent a pivotal asset for EU Member States, providing research and testing facilities to Community researchers. Schemes like the JRC’s open access programme, contribute to fostering an environment where unique scientific equipment is shared, knowledge is transferred to young talents, thus preserving skills,

innovation is stimulated, the research-industry gap is bridged and collaborative efforts throughout Europe are encouraged[49].

Strengthening safeguards implementation and non-proliferation efforts in the evolving technological and geopolitical landscape.

A comprehensive, efficient and effective nuclear safeguards system, both at European and international level serves as a crucial element in the global effort to prevent nuclear proliferation and to ensure that nuclear materials are used exclusively for their intended peaceful purposes. The nuclear landscape evolves with emerging technologies, (new fuels, reactor types and fuel cycle facilities requiring new analytical methods, reference materials and standards) against the backdrop of shifting geopolitical dynamics resulting in increased nuclear proliferation risks. Therefore, the Euratom safeguards must adapt accordingly and R&D activities, carried out by the JRC, play an essential role in addressing these challenges, from supporting the implementation of the Euratom safeguards to conducting R&D in the use of advanced technologies and digital applications and ensuring international scientific cooperation through the European Commission Support Programme to the IAEA on safeguards[50]. In the face of heightened nuclear proliferation risks, strong emphasis is also put on capacity building to provide specific training to Euratom and IAEA safeguards inspectors. As nuclear technology evolves, so do potentially the methods of misuse and deviation of nuclear materials from peaceful uses. Research is needed to adapt safeguards to these new challenges and ensure they remain effective. Also, any expansion on the number of facilities covered by Euratom safeguards can bring the research capacity, if maintained at the current level, below the critical threshold.

To curb nuclear proliferations risks, strategic items are subject to the EU export control framework under the dual-use regulation, as well as to sanction measures. The new EU dual-use Regulation 2021/821[51] faces challenges on its harmonized implementation, which Euratom direct actions notably aim to address.

Strengthening emergency preparedness and enhancing nuclear security through combating illicit trafficking, including developing nuclear forensics.

In the current security context, the necessity to mitigate unconventional threats and to reinforce capacities of national authorities in and outside of the EU is more essential than ever. Minimising the risk of terrorist use of radioactive materials and mitigating insufficient security in a variety of facilities/locations (often originating outside Europe) requires full attention. Combating illicit trafficking relies on advanced detection technologies and the combined training of border guards/customs/inspectors and front-line officers, in field response and

[49] Seibert, A., et al. The nuclear research infrastructures open access scheme of the Joint Research Centre (JRC) at the European Commission – Contributions to education, training, mobility and scientific excellence, NUCLEAR ENGINEERING AND DESIGN, 2024

[50] Aregbe, Y.,et al., The Joint Research Centre Supporting Nuclear Safeguards, Publications Office of the European Union, Luxembourg, 2023

[51] Regulation (EU) 2021/821 of the European Parliament and of the Council of 20 May 2021 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items

analytical skills. It also requires underpinning research enabling method and nuclear forensic signature development to understand the correlations between measurable material properties and the history of the nuclear material[52].

Research and capacity building on unconventional threats in the context of the CBRN (chemical, biological, radiological and nuclear) security framework of the Union remains pivotal to supporting the European internal security strategy and the external action goals.

The Russian war of aggression against Ukraine has also raised the threat of nuclear and radiological risks calling for reinforcing emergency preparedness and response. Existing capacities on environmental radioactivity monitoring and the management of the radiological environmental monitoring data system (EURDEP) are more essential than ever to provide a comprehensive in-time picture of radiological conditions across Europe.

Supporting nuclear innovation and radiation protection with adequate nuclear data, quality of nuclear measurements and reference materials

The nuclear sector relies on a wide array of modelling techniques, enabling the analysis of individual components and materials, and up to entire systems.

Although nuclear data is broadly available for a large number of radioisotopes, there are still gaps, and uncertainties, which can become more critical as innovative applications of nuclear science and technology are being developed. To overcome this obstacle and guarantee the accessibility of highly reliable nuclear data, it is crucial to coordinate national and European research, expertise, and infrastructure in the EU.

Similarly, accurate measurements of radioactivity are becoming increasingly important today, including for monitoring natural radioactivity, potential accidental releases or human exposures linked to nuclear medicine. This calls for harmonised measurement procedures and well-established calibrations in radioactivity monitoring laboratories. The provision of certified nuclear reference materials is also fundamental for the verification, validation and comparability of measurement results and hinges on the availability of specialised infrastructure.

This work overall supports the development of standards that determine the way nuclear science and technology applications should be managed.

Organisation of Euratom research and links with Horizon Europe

The interim evaluation[53] indicated that there were limited effective synergies between Euratom programme and Horizon Europe due to the lack of specific provisions, systematic screening via a permanent governance structure and different budget levels. Those synergies have mostly been restricted to the use of MSCA fellowships for nuclear researchers and cross-references between the work programmes. In the future, there should be greater focus on operational

[52] Tsiogka, V., Wallenius, M. and Mayer, K., Nuclear Forensics Casework at the Joint Research Centre, Publications Office of the European Union, Luxembourg, 2023

[53] SWD (2025) 54

provisions to foster specific synergies in a limited number of relevant and complementary fields between the Euratom Programme and Framework Programme. Commission services should collaborate closely and devote significant resources to understanding fully the two programmes and finding the best complementarities. Accordingly, the programming of Euratom and Horizon Europe actions should be closely coordinated, including a systematic screening for opportunities in synergies during preparation of Horizon Europe and Euratom Work Programmes. The Euratom Programme should also be fully integrated into mechanisms providing for synergies between EU spending programmes including with the Framework Programme, as well as supporting relevant aspects of SMR Alliance, the new Net-Zero Industry Act and providing science base for the implementation of Euratom legislation.

Concerning the Euratom Programme's governance, there is a need for a strategic discussion between the Commission, EUROfusion partnership, Joint Undertaking 'Fusion for Energy', and the Member States to cover all strategic issues related to the fusion development and delivery of electricity by a first fusion power plant, as the comitology structures (programme committees providing advice on the work programmes) do not fulfil such a role. In 2024, the Commission launched the Fusion Expert Group (FEG)[54], an ad-hoc Commission Expert Group, bringing together Member States and stakeholders to provide advice on strategic fusion issues. Based on the FEG experience, more permanent structures could be foreseen for the future Euratom programme.

Stakeholders participating in the public consultation for interim evaluation of Euratom programme 2021-2025 identified some challenges for the implementation of the Euratom programme[55]. The complex application process was a major concern, with 40.51% of respondents finding it burdensome. Additionally, limited financial resources and inadequate awareness of the programme were cited as significant barriers by 35.9% of participants. These challenges highlight the need for administrative streamlining and increased outreach to ensure that the programme remains accessible to a broader range of stakeholders.

[54] https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupId=3929

[55] See Annex V to SWD(2025)54

2.5. Past experience, lessons learnt and going forward

The latest assessment of Euratom actions is provided in the interim evaluation of the 2021-2025 Programme[56] which concluded that the actions funded by the Programme over four years help Member States to work together to develop nuclear technologies, regardless of their national choice as to whether to generate or consume nuclear power. This enables Member States to harness the opportunities offered by the technologies in the interest of all, while reducing the risks associated with ionising radiation. The recent Euratom actions deliver results and provide a supportive framework for developing, sharing and maintaining expertise and skills in nuclear safety, safeguards and security, strategic trade control, the safe management of radioactive waste and radiation protection. They also bring the EU closer to achieving practical use of fusion energy. This knowledge will be essential for those Member States that want to pursue nuclear energy as part of their energy mix (whether the technology is domestic or imported), and for those that need reassurance that nuclear power plants in neighbouring countries meet the highest safety and safeguards standards. The public also stands to benefit from Euratom funded research on other applications of ionising radiation, in particular in medicine.

2.5.1. EU added value

Interim evaluation provided clear evidence of EU added value of the Euratom programme:

With the civil use of nuclear technology being of interest to all Member States, there is a **rationale for complementing, at EU level, public and private nuclear research actions in Members States, for sharing knowledge and for taking advantage of economies of scale, while ensuring that national preferences are considered.** Significant benefits can be unlocked by the EU action in the various areas of nuclear science and technology where national research would otherwise not happen. Examples include cost-intensive research, which often requires a sufficiently high level of investment and costs sharing to be successful: research infrastructure (such as the ITER, IFMIF-DONES, JET, research reactors and facilities for characterization of highly radioactive fuel and material compounds) and the European institutions and Euratom partnerships[57] providing for coordinated access to them (JRC, EUROfusion, CONNECT-NM, EURAD 2).

The Programme significantly **increased the EU's ability to mobilise a wider pool of excellence, expertise and multidisciplinary in nuclear research**, achieving impacts that extend far beyond what would have been achieved at national or regional level. This is of particular benefit to smaller Member States, which were able to take advantage of economies of scale afforded by the Europe-wide pooling effect and open access to JRC nuclear research facilities.

- More than **7200 researchers participated in joint exploitation of nuclear research facilities** in the EU[58]

[56] COM(2025) 61

[57] See footnote 55

[58] Researchers who participated in experimental campaigns managed by EUROfusion, and accessing nuclear research facilities through OFFERR and the JRC Open Access programme.

- Programme enabled **access to about 244 research facilities**[59] across EU and in 3rd countries.

The Euratom-funded projects and JRC direct actions provide a **supportive framework for developing new generation of researchers**, sharing and maintaining expertise and skills in nuclear safety and security, the safe management of radioactive waste and spent fuel, and radiation protection.

- **986 PhD students** in nuclear research benefitted from Euratom financial support and access to critical mass of researchers and scientific equipment[60].
- **962 students benefitted from Euratom mobility support**[61]
- **3324 persons provided with specialised nuclear training by JRC**

Results of the public consultation for interim evaluation show that stakeholders consider changes introduced by 2021-2025 Programme as increasing relevance and strengthening the impact of the Programme (see Box below)[62].

Box –What messages emerged from public consultation on Programme's relevance?

1. **Introduction of co-funded European Partnerships** contributed to an increased relevance and strengthening of the impact of the Euratom Programme: 29% (57) - to great extent; 34% (67) – somewhat; 5% (10) not at all; 5% (10) – a little; 2.5% (5) doesn't make a difference; 24% (46) don't know.
2. **Launch of the European platform promoting transnational access to nuclear research facilities** (OFFERR project) contributed to an increased relevance and strengthening of the impact of the Euratom Programme: 37% (73) - to great extent; 25% (48) – somewhat; 3% (6) not at all; 3.5% (7) – a little; 7% (13) doesn't make a difference; 25% (48) don't know.
3. **Support for mobility, education and training through a platform established by the European Nuclear Education Network** (ENEN2Plus project): 46% (89) - to great extent; 28% (54) – somewhat; 0.5% (1) not at all; 4% (8) – a little; 4.5% (9) doesn't make a difference; 17% (34) don't know.

Structuring effect of the Euratom co-funded European partnerships - European Partnerships in fission[63] and fusion research[64] deliver European added value through the development of long-lasting knowledge networks. All Partnerships have a strategic research agenda or work programme which brings together the EU and other partners such as Member States, industries and foundations, in agreeing on joint priorities for funding. This is a key feature that distinguishes partnerships from other collaborative projects[65]. Euratom Partnerships provide national laboratories opportunities to specialise in some key areas, make meaningful contribution, and maintain visibility within the European consortium. Partnerships also excel in providing opportunities for sharing of knowledge and best practices. For example,

59 Facilities made accessible through OFFER, JRC Open Access and EUROfusion.
60 Supported by EUROfusion, PIANOFORTE Partnership and Euratom collaborative projects.
61 Supported by ENEN2Plus and Pianoforte Partnership
62 SWD(2025)54
63 https://pianoforte-partnership.eu/ , https://www.ejp-eurad.eu/ , https://www.connect-nm.eu/
64 https://euro-fusion.org/
65 Biennial Monitoring Report on European Partnerships, 2024, p. 19, https://data.europa.eu/doi/10.2777/991766.

EURAD-2, partnership for radioactive waste management, provides knowledge for Member States with small inventories of radioactive waste (e.g. from hospitals and industry). These Member States face particular challenges concerning access to sufficient expertise in developing disposal options.

Data also show that the 2021-2025 Euratom programme's grants (EUR 812 million) lead to a **significant mobilisation of public and private funding from beneficiaries** – about EUR 547 million. This is equivalent to a **leverage factor of 0.401**: in other words, each euro the EU is investing in Euratom R&I projects directly attracts additional R&I investments for about 40 cents. In principle, due to their design and size (76% of all Euratom grants), co-funded partnerships leveraged the most (45 cents for each Euro invested)) compared to collaborative projects (Research and Innovation Actions, Innovation Actions, Coordination and Support Actions) which leveraged about 21 cents for each Euro invested by Euratom.

One of the key aspects of added value of Euratom Programme relates to its **ability to promote cooperation on a large scale across countries**. Most national (or regional) programmes may fund bilateral or, more rarely, trilateral collaborations, but usually they do not fund wider collaboration networks[66]. Of the EUR 812 million signed Euratom grants by December 2024, 24% are for collaborative grants and 76% for Partnerships. **Collaborative grants involve an average of 16 participants.** On the other hand, three co-funded European Partnerships in fission research, involve on **average about 81 participants each**.

The added value of collaboration is reflected in feedback from public consultation on interim evaluation of the Euratom programme 2021-2025 (see box below)[67].

Box – Results of public consultation - what are the main benefits of participating in the Euratom Programme 2021-2025 compared to national or regional R&I programmes? ***[respondents could indicate more than one answer]***

1. 79% of respondents **- improved cooperation with partners from other countries** (within the EU and beyond)
2. 36% of respondents - **improved international visibility**
3. 35% of respondents - **possibility to finance projects** which otherwise wouldn't have been supported at the national or regional level
4. 27% - respondents - **improved excellence in nuclear R&I** (e.g. more high impact publications and patents)

The EU added value of the JRC's nuclear activities lays in the provision of robust scientific and technical expertise to the Commission's services and EU Member States, strongly contributing to the safe and safeguarded use of nuclear technology. The specificity of the JRC's scientific advice and support to EU policy is tied with its scientific excellence, neutrality and independence from national, private and other external interests. Moreover, the high quality of the scientific contributions is based on multi-disciplinary in-house competences in nuclear

[66] European Commission (2024). Align, act, accelerate, p. 20, https://op.europa.eu/s/z14n
[67] SWD(2025)54

safety, safeguards and non-proliferation, strategic trade control, nuclear data and non-energy applications of nuclear technologies and on its often unique research infrastructure at EU level.

The Council's decision in 2021 to reduce the budget for the programme by 20%, driven by the mobilisation of resources for addressing COVID pandemic and a priority shift to post-pandemic recovery and resilience, limited possibilities to fund excellent research proposals. It also hampered the JRC's efforts to address the emerging challenges with the necessary flexibility and capacity at a time of renewed interest in nuclear technologies.

2.5.1. Findings from interim evaluation of 2021-2025 Euratom actions

Interim evaluation provided the important **findings on indirect actions:**

- the 2021-2025 scope and level of funding of the Programme is not sufficient if Europe wants to catch up with international competitors in fission and fusion; address key issues for the development of SMRs, advanced fuels and fuel cycles; and substantially increase nuclear skills in the EU.
- Euratom co-funded partnerships in fission (radiation protection, radioactive waste, nuclear materials) are the result of long-term efforts by the research community, stakeholders and Member States to advance on a common research agenda and to address key challenges in all the fields concerned. While scientific progress has already been made, the Commission need to push to further improve the organisation and operation of the partnerships[68] to ensure that the research funded by the Euratom programme remains relevant and that it tackles the most pressing challenges.
- The EU has made strong progress in fusion research through Euratom programme's funding for EUROfusion partnership, but current efforts are not enough to bring fusion energy to the market in time to meet the EU's climate goals or to boost competitiveness. To make fusion power a commercial reality, future actions must be based on realistic assumptions about the technical challenges involved and supported by adequate investment in industrial supply chains. The programme needs to evolve by addressing key technological bottlenecks, increasing private sector involvement and financing, and strengthening international cooperation where there is clear added value for the EU. The European Commission prepares a new co-programmed European Partnership that will bring together public and private stakeholders in the fusion field. Actions planned for 2026 and 2027 will lay the groundwork for this partnership and support further innovation. This new approach also requires rethinking the role of EUROfusion, which will continue to play a key part in advancing the science behind fusion, but with a clearer focus on supporting industrial development.
- The 2021-2025 programme addressed new challenges such as research on alternative fuel for Russian designed fission reactors used in some Member States, increased strategic autonomy in nuclear materials and data, and provided support for researchers in Ukraine. The results of the call for innovative applications of ionising radiation show a high interest

[68] Evaluation indicates the need for a simplification of partnerships' structures and application procedures to broaden participation, to enhance synergies with other sectors and to introduce more flexible funding mechanism to support emerging priorities.

within medicine, the circular economy[69], space exploration and environmental monitoring[70], which could be developed further in synergy with Horizon Europe.

On **direct actions**, the evaluation concluded that:

- thanks to its expertise and nuclear research facilities, the JRC benefits the Euratom Community and a number of external stakeholders by carrying out relevant direct research, providing high quality analyses, reference materials and methods, data and studies for policy support, and delivering specialised trainings on the whole spectrum of activities from nuclear safety to security and safeguards.
- The evaluation also concluded that the provision of nuclear data, measurements and reference materials by the JRC make an important contribution to the safety and safeguards assessment of current systems and future technologies such as SMRs. Analyses on ways to treat, minimise and recycle radioactive waste and spent fuel or to evaluate their characteristics and behaviour were deemed particularly relevant to advance research in this area. In the area of safeguards and non-proliferation, the JRC's expertise and research on safeguards and nuclear security also make a valuable contribution both at European and international level to reinforce non-proliferation efforts. The results of direct actions research in non-power applications, particularly in relation to the medical field are equally relevant, serving to advance research into safe and innovative uses of ionising radiation, as well as meeting EU policy goals. The JRC's education and training activities have significant added value to EU Member States, proposing a relevant complement to national-level capacities. The availability of state-of-the-art nuclear research facilities continue to represent a high added value at EU level, contributing to independent quality research benefiting the Euratom Community and complementing Member States capacities. The direct actions also provide technical support to the implementation and monitoring of EU policies in nuclear safety, radioactive waste and spent fuel management, radiation protection, nuclear safeguards as well as non-proliferation initiatives.
- The stringent budget cuts to the Euratom Programme 2021-2027, led the JRC to introduce a new strategy for its nuclear activities, with actions to prioritise, consolidate and rationalise activities, while optimising the use of its nuclear infrastructures and sustainable operation. Using a new portfolio approach in its work programme, the JRC aims to improve synergies across research domains, improve foresight capability for analysing upcoming trends and enhance communication efforts to showcase research results.

On the **EU contribution to ITER**:

Data show that EU participation in ITER through F4E has had an important economic, social and technological impact. Expenditure related to ITER has benefited to a wide range of European companies, which have been able to demonstrate their excellence, develop new skills,

[69] For example to retrieve, from irradiated nuclear fuel, valuable rare earths and platinoids needed for key advanced technologies (e.g. renewable energies) which are in short or geopolitically not reliable supply.

[70] For example, the measurement of gamma-ray emitting radionuclides in marine reference materials, such as shrimp

and sometimes export their know-how. According to the evaluation, carried out in in 2019[71] on the impact of the ITER activities in the EU, 34 000 jobs year were created between 2008 and 2017.
A follow-up study commissioned in 2021[72] concluded that the return on investment of ITER is around 1:1, and projections indicate that by 2030, ITER could generate an additional EUR 15.9 billion in Gross Value Added (GVA) and create 72 400 job-years.

While these figures show a positive economic impact, the ITER project has experienced major delays since its beginning, resulting in the postponement of the experimental phase. The delays in project execution were mainly due to design immaturity, lack of quality of some components supplied by some DAs requesting repairs, regulatory challenges COVID-19 crisis and the war in Ukraine, which disorganised the supply chain and contributed to the delays in the delivery of key components.

In order to bring the project back on track, several measures were implemented, under the supervision of Euratom. In 2022, the new Director-General of the ITER Organization (IO) launched a series of reforms aiming in particular at (i) improving the IO's organisation, putting a project matrix structure in place to streamline the decision-making process, (ii) improving and enforcing enhanced quality control procedures, as well as repairing key components, (iii) redefining its interactions with the French Nuclear Safety Regulatory Authority (ASNR).

In 2024, the IO presented a revision of the project Baseline (scope, schedule and cost), to mitigate key assembly and commissioning risks, define contingencies for schedule and cost, while incorporating lessons learned from previous first-of-their-kind activities. This Baseline is underpinned by a phased-licensing approach aiming at reducing risks.

Euratom also identified the need to better integrate Fusion for Energy activities with those of the IO to improve project efficiency. As a result, IO and Fusion for Energy explored ways to better integrate their activities and exploit the potential synergies and complementarities between the two organisations. Since September 2023, a major effort has been undertaken by Fusion for Energy and IO to identify the most relevant activities, tools and functions. The expected outcomes of the integration are efficiency gains and potential savings, as the IO and Fusion for Energy could jointly identify optimisations in the way components are designed, procured and delivered.

In 2024, the project achieved an unprecedented execution rate which surpassed all previous years. This excellent performance was confirmed in the first semester of 2025, with indicators showing that the current project activities are on schedule, and executed slightly under cost estimates.

[71] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0147
[72] https://op.europa.eu/publication-detail/-/publication/3db11048-6a89-11eb-aeb5-01aa75ed71a1, ISBN 978-92-76-29352-1 doi:10.2833/51838

3. OBJECTIVES FOR EURATOM PROGRAMME 2028-2032

3.1. General and specific objectives

The general objective of Euratom programme is to strengthen the Union's competitiveness and decarbonisation, inline with the general and specific objectives of the ECF and Horizon Europe, while protecting people and the environment, by advancing research and training in nuclear science and technology in synergy with Union programmes.

The programme's specific objectives are:

(a) support the construction and operation of ITER, ensuring performance-based funding for the delivery of European components by Fusion for Energy, the integration work by the ITER Organization and that technical and scientific lessons learnt from ITER benefit the Union;

(b) advance fusion research, supporting the transition from basic science to technology, engineering and innovation, foster the development of the Union's fusion industry, support the emergence of start-ups and innovative concepts for enabling future fusion power plants, and strengthen international cooperation;

(c) advance research on nuclear safety, security and safeguards, non-proliferation, radiation protection, nuclear data, the management of radioactive waste and spent fuel and the innovative use of ionising radiation including in the medical sector;

(d) develop, retain and utilise expertise and competencies in the nuclear field through education and training and support access to state-of-the-art research infrastructures, ensuring their long-term sustainability and operational excellence; and

(e) provide independent and science-based policy support to Union policies and develop the knowledge base for standardisation and modelling.

3.2. Expected results of the programme

In **fusion energy development**, the Euratom Programme will **accelerate the development of key enabling technologies**, transitioning from pure research to innovation, towards commercialisation, also supporting the emergence and consolidation of innovative and competitive fusion players in Europe. It will enhance competitiveness of EU industry and start-ups in fusion field: targeting high-priority technology areas with significant business potential, for fusion applications and beyond. While keeping the research and development focus on magnetic confinement as the most mature concept for future fusion power plants, the programme will be helping academia and start-ups to demonstrate alternative concepts and encouraging the industry to deliver innovation for cross-cutting technologies (e.g., fusion-grade materials, tritium breeding).

ITER will remain a cornerstone for the development of fusion energy in Europe, and the programme will aim to complete construction for the first phase of experiments on time and within budget. This will be achieved by **delivery of European components for ITER** in line with the project baseline, supervising Joint Undertaking 'Fusion for Energy' in performance of

its tasks, while ensuring that technical and scientific lessons learned from ITER benefit the Union.

In fission research: the Programme will advance research to ensure the safe, secure and safeguarded use of reliable nuclear technologies, and support the management of present and future nuclear infrastructure for Europe, while reducing radiation risks and improving the safe management of radioactive waste. The Euratom community will benefit from reinforced action into the following priority areas:

- **Safe nuclear power and nuclear innovation for a safe, secure and prosperous future.** With due consideration for the energy mix options of Member States, Euratom fission will conduct R&D on the safety and security of SMRs and analyse the needs for the European supply chain, including in terms of competences. The programme will also promote research on AMRs, innovative fuel cycles and materials, and a broad range of other nuclear technologies, including applications beyond energy production, such as for the health sector, cogeneration or space exploration. Euratom actions will also support the development of tools and knowledge contributing to the safety of existing reactor systems, including those going through long time operation or projects of new build of large conventional reactors. JRC's in-house modelling capacities will contribute to better understand the behaviour of energy components and systems by integrating research and experimental data.
- **Improving citizen's life with nuclear medicine** by supporting the development of new technologies and investigating innovative applications of ionising radiation and medial radionuclides used in the fight against cancer and other diseases.
- **Reduction of radiation risks** by the development of knowledge and tools for improving radiation protection and emergency preparedness & response in the event of a radiological accident.
- **Strengthening EU and global nuclear non-proliferation efforts** through development of innovative tools and methods for nuclear safeguards verification, trainings of safeguards inspectors and other direct support to the implementation of Euratom and IAEA safeguards, in synergy with R&D in nuclear security and nuclear forensics to respond to illicit trafficking and criminal use of radioactive materials.
- **Reinforcing decommissioning and managing radioactive waste and spent fuel** by actively pursuing decommissioning of nuclear facilities and in parallel R&D to improve the management of nuclear waste and spent fuel: developing waste management solutions for new technologies, fine-tuning characterisation techniques and providing support for Member States in the defining of their national strategies for long-term storage and disposal with a specific attention for early-stage programmes and smaller waste inventory (e.g. in the medical sector) or for waste streams without mature or efficient processing methods.
- **Contributing to a boost for nuclear skills, competences and access to nuclear research infrastructures in the EU**. The goal is to contribute to the maintenance and development of nuclear skills, through research collaborations, trainings, enhanced dissemination of scientific knowledge, foresight activities and open access to European Commission's

research facilities. The action will ultimately aim to maintain strategic competences, supporting a qualified workforce in the EU, and helping build nuclear capacities across EU Member States.

4. ALTERNATIVE DELIVERY MECHANISMS AND RISK ASSESSMENT

4.1. Option 1 – Business as usual for Euratom research and training (baseline scenario)

Baseline scenario for 2028-2032 entails no major changes to the directions of research and the way the Euratom contribution to the ITER project is implemented. Option 1 would also mean continuation of limited synergies between Euratom programme with Horizon Europe Framework Programme and the European Competitiveness Fund. In terms of resources, the budget would be maintained at the 2021-2027 level.

Analysis of directions of Euratom-funded actions under Option 1:

Euratom actions on fusion research would remain almost entirely focused on supporting collaborative scientific activities undertaken in the EUROfusion Partnership, with a centre of gravity largely – if not entirely – directed to academia and public laboratories. While excellent science should remain core to the programme, such an exclusive focus could be detrimental to effective technology transfer and hinder the maturation (ultimately, commercialisation) of key fusion technologies.

The role of the fusion industry and start-ups under the programme, while acknowledged, would remain limited in terms of scale and impact – especially in setting strategic orientations. This would be detrimental to the interest of the private sector in contributing to the programme and would result in a lack of coordination between public and private research, missing an opportunity to build synergies and consolidate a competitive industrial base in Europe. Only limited EU funding opportunities would be available to European start-ups that develop innovative concepts and technologies for future fusion power plants, hindering their capacity to attract private investments and their growth. Research supported by Euratom would remain entirely centred on mainstream, more mature concepts, missing the opportunity to support promising alternative pathways to the realisation of fusion power plants.

For the **Euratom contribution to the ITER project** it is important to underline that the purpose of the overall EU contribution to the ITER project is to finance the completion of the construction phase of ITER in an improved and efficient manner, preparing the grounds for its future commissioning and operation in 2034. Therefore, keeping the same approach as in the past will not allow for the management of the EU budget for the ITER project in a more efficient and streamlined manner.

Limited synergies between Euratom programme, Horizon Europe and ITER project

Continuation of the Euratom programme as implemented in 2021-2027 would mean, limited effective synergies with Horizon Europe and ITER-related actions due to the lack of specific provisions. Cross-cutting nature of EUROfusion and F4E activities underlines the need for a

strategic discussion between Commission, EUROfusion, F4E and the Member States to cover all strategic issues related to the fusion development is required and currently underway under various workstreams, namely through the ad-hoc Fusion Expert Group report[73], the call for evidence[74] and development of the EU fusion strategy (foreseen for adoption at the end of 2025).

Consequences of maintaining resources for Euratom research at 2021-2027 level

The Euratom programme's budget has been impacted by 20% decrease between the previous financial period (2014-2020) and the current one (2021-2027) due to various factors, including COVID-19 pandemic. These funding limitations have affected the programme's ability to fund research across the wide arrays of nuclear fields, as well as to properly address emerging challenges and priorities.

The baseline scenario, maintaining Euratom resources at 2021-2027 level would limit the scope of research, both under direct and indirect actions, to a restricted core of nuclear activities in fusion, nuclear safety of existing systems, radiation protection, nuclear safeguards and security and management of radioactive waste and spent fuel. The Commission would face the dilemma of whether to prioritise funding to the co-funded Partnerships and for ongoing actions supporting access to infrastructures and nuclear expertise or prioritise competitive calls for proposals for innovative solutions.

Amongst the topics of relevance for Member States and stakeholders feature the safety and safeguards assessment of existing and future nuclear systems, including in relation to structural materials, supply chain and fuel cycles. Covering these existing and emerging research fields is particularly challenging in view of the Programme's reduced budget. Addressing innovative areas of research would be difficult while ensuring an adequate management of resources, and the optimal use of the Commission's nuclear research infrastructure and competences would become exceedingly challenging.

Under the baseline scenario, the JRC would continue to provide core technical and scientific support to the European Commission to guarantee the effective implementation of nuclear safeguards, however, with necessary limitations to the depth and scope of involvement. Activities include a rigorous analytical and quality system, supported by metrological quality control tools, to ensure the accuracy of nuclear materials measurements. The in-house capacity to support safeguards assessment would be limited to core activities, analytical services, and technical support requests, thus neglecting further R&D into innovative concepts and systems in safeguards. This together with a decrease in the provision of safeguards reference materials would threaten to weaken Commission's safeguards analysis capabilities and ultimately the Euratom safeguards regime, as well as reducing the support programme to the International Atomic Energy Agency.

[73] https://op.europa.eu/en/publication-detail/-/publication/51364c97-135b-11f0-b1a3-01aa75ed71a1/language-en
[74] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14717-EU-fusion-strategy_en

In the area of non-power applications, research on medical radionuclides has reached particular momentum at EU level, supported by unique expertise and infrastructure, the JRC notably pioneering R&D on the development of innovative oncology treatments such as targeted alpha therapy (TAT). Demand for such expertise is increasing and expected to rise further in the medium to long-term, however the baseline scenario would make expanding R&D scope to other radionuclides, collaborations and capacity building programmes too challenging.

A chief concern amongst EU Member States is advancing research on sustainable solutions for the management of spent fuel and radioactive waste, focusing on final repositories and long-term storage of spent fuel. The baseline scenario would limit research to core areas, preventing exploration into important topics such as partitioning and transmutation where these activities are expected to grow in importance as advanced reactor systems and closed fuel cycles technologies are developed.

Restraining the Programme to its current scope and funding size undermines its ability to adequately address rising challenges regarding nuclear competences and skills relevant to all fields of nuclear research. The baseline scenario would also impact the Programme's ability to efficiently support nuclear research infrastructures, which are the cornerstone of research and training in the nuclear field, essential for conducting experimental studies and analyses, producing reliable and valuable data, building capacity, as well as supplying isotopes for medical and industrial purposes. The Programme in its current shape is limited in its support to European nuclear research infrastructure and unable to efficiently ensure their operational sustainability beyond providing financial support to European researchers through the European User Facility Network (OFFERR project) and Open Access programme of the JRC to access European Commission's research facilities. The management of these latter infrastructures by the JRC induces a considerable allocation of staff and operational and maintenance costs to comply with the legal obligations of the nuclear licenses. These expenses would continue posing a significant challenge under the baseline scenario, while appropriate staffing of laboratories is essential to perform technical and scientific analysis in support to policies, and to provide quality trainings for the benefit of the Community.

While the demand for JRC's nuclear expertise and scientific advice has been increasing, as indicated by the numerous contacts and requests from different organizations in EU Member States, for e.g. requests of regulators for expertise for environmental assessments or nuclear safety trainings, or startups looking for collaborations on the definition of criteria for safety and safeguards by-design. A reduced research capacity, which would continue under a baseline scenario would bear a non-negligeable impact on the JRC's ability to provide the entire range of policy support services to other EU services and Member States and hinder the capacity to respond to ad hoc requests for policy support. Available resources would necessarily focus on addressing JRC's specific policy obligations derived from the Euratom Treaty and the secondary Euratom legislation.

Finally, under the baseline scenario, the JRC would be constrained to a reduced involvement in and contribution to consortia implementing indirect actions due to resources limitation and a necessity to prioritise core activities. In the long run, this situation risks damaging the expertise and technological leadership at EU level as addressing emerging technological challenges in

the nuclear field requires strong partnerships with national research institutions, leading to better sharing of knowledge, resources, and best practices.

4.2. Option 2 – 'Enhanced Euratom programme supporting the development of safe and safeguarded innovative nuclear technologies for a prosperous and sustainable EU'

To address the new competitiveness and energy security challenges facing the EU, and in view of meeting decarbonisation targets, the Euratom programme must be reinforced in terms of budget and measures to enhance innovation and skills in the field of nuclear science and technology. For the latter, the programme will benefit from the new Horizon Europe Framework Programme's rules for participation and dissemination designed to simplify access further, enhance openness, and maximise the impact of funding. There are areas, such as industrial competitiveness and public health where joint actions between the Euratom Programme and Union programmes can be of greater benefit to Union citizens than having actions under the Programme alone. For this reason, the Programme should seek synergies with Horizon Europe and other Union programmes. Streamlined governance should allow the Commission to discuss all aspects of fission and fusion research, including the ITER project, with Member States and key stakeholders to provide strategic overview and to improve coordination with Euratom actions, while recognising that for Fusion for Energy, the governance with the Member States is covered by the Fusion for Energy Governing Board.

4.2.1. Fusion research

Euratom actions for the development of fusion energy will be based on the EU strategy for fusion energy[75] and a public-private partnership to promote its rapid, economically viable commercialisation[76]. The partnership should aim to create a stable and predictable ecosystem for industrial innovation, leveraging the ITER project, while ensuring a clear technology development roadmap. These actions will build on the strengths and achievements of the established organisations for excellent science (notably EUROfusion partnership), international cooperation, and skills. The deployment of fusion energy will require use of different funding tools of the EU Budget to unlock private, institutional and national investment.

Specific Euratom actions will include:

- Re-focussing EUROfusion, the flagship EU fusion research partnership, ensuring it leads the scientific agenda while focusing on the joint exploitation and operation of existing and future research infrastructures—both within the EU and globally.
- Scaling up the European Public-Private Partnership for Fusion Energy, which pilot phase is taking place in 2026-27. The partnership will allow to develop, consolidate and structure the European fusion industry, including at the level of the supply chain – building on European excellence in fusion research and allowing for a massive transfer of knowledge from the labs.

[75] Under preparation, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14717-EU-Fusion-Strategy-_en

[76] https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en

- Providing bottom-up support for the emergence and growth of innovative European fusion start-ups, grating easier access to proven instruments of the European Innovation Council Programme[77], and allowing them to advance alternative fusion concepts and key enabling technologies for fusion power plants as well as to attract private investments more effectively.
- Broadening opportunities for EU research in inertial confinement fusion, in line with recent landmark scientific achievements and the technology neutrality principle, providing targeted support (e.g., in the advancement of plasma and neutron diagnostics, and of fundamental physics of laser-target interaction and hydrodynamic instabilities) to an established scientific community, and boosting synergies between public research and innovative companies.

Additional new actions of the Euratom Programme with the supplementary budget planned in the MFF 2028-34 (compared to 2021-27) would be implemented in support to and in synergy with the possible Moonshot Fusion Energy[78]. These actions would include:

- the development and construction of a dedicated technology facility (a 'Fusion Pilot Plant') that should work alongside ITER and DONES to demonstrate the integration of the solutions for the key technology gaps[79] and enable non-negligible production of electricity (compared to the input power).
- the development and construction of an ignition-grade implosion facility for inertial confinement fusion that will bring back inertial fusion to the EU. This will also contribute to the Commission's initiative Choose Europe, attracting the best-talented scientists and providing a boost to the relevant industrial ecosystem.

4.2.2. Euratom contribution to ITER

Despite the ITER delays and the emergence of public and private fusion initiatives that could potentially challenge the relevance of the EU contribution to ITER, stakeholders (including companies and laboratories) still consider that the ITER project is a unique project capable of addressing the technological challenges of fusion in an integrated manner. Private initiatives, particularly led by startups, often present optimistic plans for early achievements but typically do not constitute substitutes to ITER. They could be effective in complementing ITER results in responding to the EU needs and policies (e.g., achievement of the objectives at a smaller cost, for instance through joint procurement activities). EU participation to ITER has therefore

[77] https://eic.ec.europa.eu/index_en

[78] Proposal for Horizon Europe Framework Programme (COM(2025)543) provides for moonshots' projects (including in fusion energy) with a strong scientific component, boosting EU-wide value creation and strategic autonomy.

[79] This includes addressing gaps in areas like plasma-facing components, tritium fuel cycle, exhaust power handling, and integration of plasma physics and engineering systems.

retained its full relevance as demonstrated by the recent external study of the EC [80] and the 90 responses to the Call for Evidence on the European Fusion Strategy[81]

The continued financing of EU participation in the ITER project will secure resources commensurate with the needs of ITER for integrated commissioning, and start of research operations scheduled in 2034.

The programme would ensure that the ITER project is put back on track through improved measures, such as: timely implementation of the revised baseline; adaptation of the IO and F4E performance indicators and milestones; appropriate integration of IO and F4E activities; due consideration of contingencies; and close interaction and dialogue with the regulatory authorities.

4.2.3. Fission research

The new Euratom Programme should clearly define its objective of supporting the development of safe, secure and safeguarded innovative nuclear technologies for a prosperous and sustainable EU. Strategic priorities for the next programme would include:

- **Safe nuclear power for the EU:** the development of innovative nuclear technologies, such as SMR, and their foreseen deployment in the EU, represent a potentially viable and competitive technological solution to meet the Union's decarbonisation goals especially in hard-to-abate energy intensive sectors, complementing existing assets and aiding EU's strategic autonomy. There is therefore a need for harmonized European approach to SMR safety and safeguards requirements in view of optimising and facilitating the licensing process and to ensure that technologies are verified and validated independently through an early integration of safety, security and safeguards requirements into the designs. Ensuring the safe deployment of these new systems requires sufficient support from the research side to demonstrate the passive safety features, the advanced control systems, improved materials and fuel performance. It also necessitates a thorough analysis of the future European supply chain and the associated workforce availability.

  In parallel, the research provided under the Euratom programme needs to address the lifetime extension of several nuclear installations in the EU to ensure their continued operational safety and maintain a dispatchable supply of low carbon energy. Ageing nuclear reactors in the EU requires continuous improvement of safety standards and to address the issues common to different designs and technologies such as ageing management, structural integrity assessment, and defect tolerance evaluation.

- **Nuclear innovation and modelling for a safe and prosperous future:** for the longer term, Euratom research will focus on safety and safeguards aspects of advanced nuclear technologies, including Advanced Modular Reactors (AMRs), innovative fuels and materials. In line with advancing technological innovation, the efficiency and safety of

[80] External study: European Commission: Directorate-General for Energy, Pancotti, C., Catalano, G., Colnot, L., Banfi, S. et al., *Interim evaluation study of the implementation of the Council decision (Euratom) 2021/281 amending decision 2007/198/Euratom establishing the European joint undertaking for ITER and the development of fusion energy and conferring advantages upon it – Final report*, Publications Office of the European Union, 2025, **https://data.europa.eu/doi/10.2833/1515037**

[81] Commission launches Call for Evidence to support first-ever EU-wide Fusion Strategy

the nuclear fuel cycle management requires attention with the research supporting new types of fuels such as accident tolerant fuels (ATF) to address relevant safety and safeguards aspects and advanced fuel cycles to reduce long-lived radioactive waste. Improved fuel cycle management also hinges on strengthening the security of supply of nuclear fuel, including by achieving autonomy on raw materials acquisition and the fuel production chain. JRC in-house modelling capacities will contribute to better understand the behaviour of energy components and systems by integrating research and experimental data.

In addition to electricity production, a prosperous and sustainable EU requires research on a broad range of other nuclear technologies, including applications beyond energy production, cogeneration, space exploration, and maritime use.

- **Strengthening nuclear safeguards, security and non-proliferation:** the emergence of new technologies poses a particular challenge to the Euratom safeguards system, requiring a holistic approach to address current technology, as well as advanced systems poised to go into operation in the coming years. An enhanced Euratom programme would support research to introduce safeguards approaches at the design stage, alongside safety and security provisions, to the back end of the fuel cycle facilities, as well as to future reactor systems. Recent geopolitical developments have shown the importance of reinforcing capacities to enable strategic trade and export control, technical support to defining and monitoring the sanction lists, as well as proliferation risks analysis. Further, maintaining expertise in nuclear security relies on the use and availability of advanced detection technologies, the continued provision of training to border and front-line officers to bolster in-field response, as well as underpinning research on enabling, analytical methods and on nuclear forensics signature development.

– **Improving citizens' lives with nuclear medicine, reducing radiation risks and enhancing emergency preparedness**: an enhanced Euratom programme would be able to adequately address the increasing interest for non-power applications of nuclear technology, especially in the medical field, while securing supply of radioisotopes for cancer treatment amid global shortages in line with the Strategic Agenda for Medical Ionising Radiation Applications (SAMIRA) adopted in 2021[82]. Euratom partnership for radiation protection would continue leading role in fundamental research in this field. The JRC's research, enabled by dedicated European infrastructure and long-standing expertise, will make an essential contribution to the innovative uses of radionuclides, by expanding current research in Targeted Alpha Therapy to other radionuclides an expanding capacity building programmes and partnerships. The Russian war of aggression against Ukraine demonstrated that the Programme will also need to focus more on emergency preparedness for radiological events, supported notably by JRC's activities in environmental radioactivity monitoring.

– **Ensuring safe and safeguarded management of radioactive waste and spent fuel**: Euratom programme could enhance Europe's global leadership in radioactive waste

[82] https://energy.ec.europa.eu/topics/nuclear-energy/radiological-and-nuclear-technology-health/samira-action-plan_en

management (RWM), by increasing the EURAD Partnership capacity to respond more dynamically to evolving needs and policy changes in this field. It would enable stronger support for Member States with smaller nuclear inventories or those in early stages of RWM programme development. The new actions could include developing waste management solutions for new technologies (SMRs, AMRs and fusion) and for waste streams without mature or efficient processing methods. The decommissioning field is gaining importance as many nuclear plants across Europe approach end of the life. This creates an opportunity for Euratom supported innovation, particularly through the involvement of small and medium-sized enterprises (SMEs) Strengthening the connection between research outputs and practical, real-world applications remains a key area for improvement. Additional funding would enable the JRC to support further research into the implementation of sustainable solutions in this area through radioactive waste and spent fuel characterization, waste treatment and conditioning, as well as the analysis of waste streams from advanced reactor systems and fuel cycles. The technical support provided by the JRC to monitor the implementation of the Council Directive 2011/70/Euratom (Radioactive Waste Directive) and insights gathered into the status of national R&D programs for waste management translate into important expertise serving the successful operation of the EURAD-2 partnership.

- **Boost nuclear skills, competences and infrastructure:** in the face of potential shortages in qualified nuclear workforce, concerns over the retention of adequate levels of nuclear skills in the EU, as well as foreseen needs in view of planned or ongoing new build projects, it is essential to address this priority issue with a reinforced Euratom programme. Such a programme would continue and expand direct support to students and researchers and bring stability and predictability for users of nuclear research facilities. Euratom direct and indirect actions would enhance specialised training and access to research infrastructure – through both the dedicated European User Facility Network and the JRC Open Access programme. To make a real difference in nuclear competences and to substantially increase number of beneficiaries, actions supporting researchers' mobility and studies at MSc, PhD and postdoctoral level must be launched in synergy with Maria Sklodowska-Curie Actions and other actions under Horizon Europe. Nuclear research infrastructure, including those managed by the JRC, are a pivotal asset for EU Member States, and the necessity to maintain their compliance with national regulatory provisions for safety and security, while ensuring continuous maintenance and operation, requires dedicated financial support.

Additional new actions of the Euratom Programme with the supplementary budget planned in the MFF 2028-34 (compared to 2021-27) would include:

- Increasing the optimal use and access of nuclear research infrastructures in Europe (both DG RTD and JRC).
- Nuclear innovation for decarbonisation of energy intensive industries incl. switch from coal to nuclear, maritime and space applications (both DG RTD and JRC).
- Safety aspects of future reactor systems and fuel cycles, including Small Modular Reactors and Advanced Modular Reactors incl. passive safety systems (both DG RTD and JRC).
- Enhanced capacity building for frontline officers and other security agents to respond to illicit traffic of nuclear material and to other unconventional CBRN threats (JRC)

- Management of radioactive waste and spent fuel incl. solutions for new technologies (SMRs, AMRs), for MS with smaller waste inventory, for nuclear fuel recycling technologies to reduce final waste volumes and for improved circular economy (both DG RTD and JRC)
- Enhancing the EU competences in the field of decommissioning including the development of AI and robotics solutions (both DG RTD and JRC).

5. PLANNING OF FUTURE MONITORING AND EVALUATION

This initiative will be monitored through the performance framework for the post-2027 budget, which is examined in a separate impact assessment[83]. The performance framework provides for an implementation report during the implementation phase of the programme, as well as a retrospective evaluation to be carried out in accordance with Article 34(3) of Regulation (EU, Euratom) 2024/2509. The evaluation shall be conducted in accordance with the Commission's Better Regulation Guidelines and will be based on indicators relevant to the objectives of the Programme. The latter shall comprise output, outcome and impact SMART (specific, measurable, achievable, relevant, and time-bound) indicators to capture the progress towards achieving the Euratom's specific and general objectives, including contribution to ITER, in the short-, medium- and long-term, respectively. Due to the Treaty's 5-years limit for the Programme, the Commission proposal could include specific provisions on evaluations, linking retrospective evaluation of 2021-2027 programme, including final evaluation of the ITER programme 2021-2027, with interim evaluation of 2028-2032 programme and impact assessment for extension of the programme for two years (2033-2034) in order to match duration of the MFF.

For ITER, following the establishment of the 2024 Baseline, in line with the horizontal [Performance Regulation], and in line with project management practices, the following output indicators will be monitored and reported for both IO's and F4E's activities:

(a) Schedule Performance Index (SPI) is used to monitor the project implementation according to the defined schedule and is estimated as a ratio between the "Earned Value" and the "Planned Value".

(b) Cost Performance Index (CPI) is used to monitor expenditures and is a measure of the value earned for the money spent. For the ITER project it is defined as the ratio between the value earned with the payments and the actual payments.

(c) Estimate At Completion (EAC) is used to forecast the total cost of the ITER project based on current performance. It indicates how much the project is expected to cost when it is finished. For F4E, EAC estimates the total project cost at completion based on the project's performance up to a given point in time.

[83] SWD(2025)590

(d) Percentage of Completion provides an indication how much the project progressed. It is defined as the ratio of the Earned Value to the Estimate At Completion.

In addition, three result indicators will be estimated through application of economic models monitored and reported, namely:

(a) The amount of ITER related contracts implemented in EU (showing their cumulative value of the ITER related contracts to the EU economy);

(b) The estimate of jobs created in EU as a result of the ITER project will identify the new employment opportunities; jobs created in the field of fusion energy and EU as a whole in the Union in the 2028-2034 period;

(c) Gross Value Added isas a measure of the value of goods and services produced in the EU economy. It will be used to assess the economic c output impacts of the ITER -related spending to the overall economy of the EU.