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COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE
COMMITTEE OF THE REGIONS**

Interim evaluation of the 2021-2025 Euratom research and training programme

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1. INTRODUCTION

This report sets out the results of the interim evaluation of the 2021-2025 Euratom research and training programme ('the programme') accompanied by the Commission's observations as required by the Council Regulation establishing the programme¹. This programme is the EU's main source of funding for nuclear research, with a budget of nearly EUR 1.4 billion. It funds the development of fusion energy and aims to maintain the highest nuclear safety, security and radiation protection standards, as well as Europe's skills in the nuclear domain.

The interim evaluation, carried out by the Commission with assistance from independent experts, analyses the programme's design, implementation and initial results. The outcome of this evaluation, provided in the attached Commission staff working document and summarised in this report, has been used to prepare and design the Commission proposal for the extension of the programme for 2026-2027.

The evaluation assesses progress in achieving the programme's objectives, efficient use of resources, and continued relevance, coherence (within the programme and with other instruments) and EU added value. It covers the period from 2021 to 2024 and assesses both indirect actions implemented by the Directorate-General for Research and Innovation (DG RTD) and direct actions carried out by the Joint Research Centre (JRC).

2. STATE OF PLAY



Source: European Commission

The programme was launched in May 2021 with a total budget of EUR 1.38 billion. By December 2024, 79% of the budget had been committed and 40% of payments made. The programme is implemented in direct management through indirect and direct actions, which make up 61.5% and 38.5% of the budget respectively.

For indirect actions, 58 project grants were signed, with EUR 810 million in Euratom contributions, following three competitive calls for proposals and assessments of proposals from named beneficiaries. In addition, the Commission provided funding of EUR 2.6 million

¹ Article 14(2) of Council Regulation (Euratom) 2021/765 of 10 May 2021 establishing the Research and Training Programme of the European Atomic Energy Community for the period 2021-2025 complementing Horizon Europe – the Framework Programme for Research and Innovation and repealing Regulation (Euratom) 2018/1563 (OJ L 167I, 12.5.2021, p. 81).

for postdoctoral fellowships under Maria Skłodowska Curie Actions (MSCAs) and for prizes recognising excellence in fission and fusion research.

For direct actions, the JRC budget (EUR 426 million for 2021-2024) is distributed across three main categories: permanent and non-permanent staff (making up over 63% of the budget), building maintenance (29%) and operational expenses for scientific work (8%).

3. RESULTS OF EVALUATION

The programme is successful in supporting pertinent research on nuclear safety, security, safeguards, radiation protection, waste management and fusion energy. It is too early to draw conclusions on the programme's impact – because only one project had been completed by 2024 and 10 more will be completed in 2025, out of 58 launched. However, available outcomes in terms of projects launched, their coverage and first results, as well as the JRC outputs, show that the programme's direct and indirect actions implemented over the last four years are relevant for achieving its objectives. The programme has delivered in terms of peer-reviewed publications (ca. 2 000) and the number of people who have benefited from training and access to research infrastructure (ca. 11 000).

Co-funded Euratom partnerships are the cornerstone of the programme, accounting for 76% of budget for indirect actions and involving most Member States (21 in waste management, 23 in radiation protection and 26 in fusion). The programme also made use of substantial funding from beneficiaries (45% of the costs) through partnerships. Progress made by partnerships is attracting more partners from non-EU countries; for instance, in radioactive waste the number of partners doubled.

Euratom-funded safety research is not limited to Member States that use nuclear power; 21 Member States are involved in different projects in this area. The programme also involves the Horizon Europe widening countries (14 out of 15 countries), benefiting from 13% of Euratom funding in fission research (an increase from 10% in 2014-2018). 'Widening countries' now account for 24% of participants in Euratom projects (an increase from 21% in 2014-2018).

Finally, reporting shows that projects launched in 2021 and 2022 reached 53% of their milestones. The data available at the time of writing shows that progress is being made in achieving the programme's objectives as explained in the sections below.

3.1. Nuclear safety

Between 2021 and 2024, the Euratom programme funded a portfolio of 34 research projects, as well as JRC research activities, addressing a broad spectrum of safety challenges for current and future nuclear systems. The direct actions also focus on specific policy support aiming to strengthen nuclear safety standards within and outside the EU. The safety of current nuclear systems remains a priority, and there were 11 projects in this field supported by grants of EUR 50 million. These were complemented by the JRC's research on design basis analysis and on materials and components. This mainly addresses safety issues linked to the long-term operation of existing nuclear power plants, such as structural integrity, non-destructive assessment of materials, model validation and severe accident simulation. Such research is more crucial than ever, as the average age of EU power plants is 38 years and they play an important role in the decarbonisation of the EU's power sector and in security of energy supply. The evaluation concluded that the programme needs to support more research on degradation and ageing of existing nuclear power plants.

The programme addressed the growing interest in small modular reactors (SMRs) by funding research with a particular focus on their safety features and passive safety systems. Five research projects, as well as research at the JRC, aim to verify potential advantages of SMRs in terms of design simplification and inherent safety features. They also address new challenges with regard to safety, security and safeguards. By supporting design improvements, Euratom-funded research facilitates the work of the European Industrial Alliance on SMRs. In addition, it should help put in place a consistent approach among regulators to safety requirements, improving safety across the EU. The evaluation concluded that, for the preparation of the safety case for SMRs, further work is needed on a wide range of research data as well as the verification and validation of simulation tools. More emphasis should also be put on responding to regulators' needs in this area.

In the area of the nuclear fuel cycle, Euratom's support focuses on the development of fuel for Russian-designed reactors in EU Member States (and in Ukraine), accident-tolerant fuel and fuel for research reactors. Nine projects supported by grants of EUR 45.6 million addressed three main issues: (i) security of supply; (ii) increasing performance; and (iii) improving safety under accident conditions. In this area, the JRC's experimental research particularly contributes to fuel behaviour analysis. The above actions are complemented by a new co-funded European Partnership for nuclear materials (CONNECT-NM) launched in October 2024, which aims to boost the safety, efficiency and economy of nuclear energy by improving the performance of materials and monitoring and predicting materials' behaviour in operation.

3.2. Radioactive waste management

The successful conclusion of European Joint Programme on radioactive waste management (EURAD) and launch of its successor, a co-funded European Partnership (EURAD-2) show that joint programming and implementation of research on radioactive waste management is well established in the EU. Member States have shown strong commitment to EURAD-2, and there is increasing interest from non-EU countries. The partnership is an important tool for transferring knowledge and experience from Member States that are at an advanced stage in terms of expertise and implementation to those that are only starting to develop management methods and disposal facilities, which helps fulfil the requirements set by Directive 2011/70/Euratom (Radioactive Waste Directive). The evaluation underlined the need to adapt the partnership to the changing situation with more deep geological facilities approved or under construction. In line with its participation in EURAD and EURAD-2, the JRC contributes to waste characterisation in its specialised testing facilities, while also providing expert reviews to support the Commission's monitoring of Radioactive Waste Directive implementation in Member States. Together with projects supporting decommissioning, the programme funded a spectrum of actions covering the specific objective of safe radioactive waste management.

3.3. Radiation applications and protection

The Commission launched nine projects, four of which involved the JRC, with EUR 50 million in grants. These cover all areas of radiation application and protection set out in the Council Regulation (non-power applications of ionising radiation, risks from low doses, emergency preparedness, environmental monitoring). PIANOFORTE, the co-funded European Partnership for radiation protection, made good progress and involved beneficiaries from most of the Member States and from non-EU countries. It therefore shows strong potential to continue playing a leading role in radiation protection research in Europe. Recommendations from the Euratom Scientific and Technical Committee (STC) propose improvements to this

action in coming years. The JRC's research, enabled by dedicated European infrastructure and long-standing expertise, makes an essential contribution to emergency preparedness through environmental radioactivity monitoring activities. It also contributes to non-power applications, particularly in medicine with the development of novel radioisotopes for targeted alpha therapy.

A substantial number of proposals submitted to calls show potential for innovative applications of ionising radiation in medicine, the circular economy, deep space exploration and environmental monitoring. This potential could be further realised in synergy with Horizon Europe, as recommended by the STC.

3.4. Nuclear security, safeguards and non-proliferation

In light of ongoing geopolitical changes, more attention is being paid to non-proliferation and security issues in the EU. From 2021 to 2024, the JRC provided training to support law enforcement, civil protection and customs in combating the illicit trafficking of nuclear material and to strengthen nuclear safeguards. The JRC also directly contributes to building capacity against chemical, biological, radiological and nuclear (CBRN)² threats and supporting nuclear security-related projects outside the EU. Direct actions research focuses on developing and improving analytical techniques and methodologies for safeguarding nuclear materials. This research makes the JRC a key player in monitoring and preventing the proliferation of nuclear materials. The JRC also carries out a substantial amount of research on nuclear safeguards to support the International Atomic Energy Agency (IAEA), as part of the European Commission support programme, and provides policy support on safeguards.

3.5. Expertise and competence in the nuclear field

The programme actions provide direct support to students and researchers and bring stability and predictability for users of nuclear research facilities. Euratom direct and indirect actions provide specialised training and access to research infrastructure – through both the OFFERR project and the JRC Open Access programme – and support researchers' mobility and studies at MSc, PhD and postdoctoral level. By 2024, more than 3 000 people had benefited from training and almost 1 000 PhD and other students had used mobility support. The first outcomes are promising, and it is expected that the European Partnerships and the JRC will achieve most of the objectives. The European Nuclear Skills Initiative, planned for 2025, should bring further guidance for Euratom action and closer involvement of industry. While the number of MSCA postdoctoral fellowships granted is low, they demonstrate an existing potential for synergies between Euratom and Horizon Europe. This could be expanded into other MSCA instruments, for example PhD networks, if funding is available. The evaluation underlined the need to continue developing an infrastructure ecosystem, including Member States and the JRC facilities, to provide a practical and sustainable means of access to research infrastructure for collaborative projects and partnerships.

3.6. Fusion energy

The co-funded European Partnership EUROfusion³ has made tangible progress from 2021 to 2024 in its experimental campaigns and research addressing the roadmap's eight missions to

² Chemical, biological, radiological and nuclear materials and agents that could potentially harm society through their accidental or deliberate release or dissemination.

³ 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>

develop fusion energy. Various indicators show that EUROfusion delivers on achieving research milestones set in 2021, supporting mobility and access to research facilities and training a new generation of researchers and engineers. Despite this, an independent evaluation has raised doubts about the adequacy of the research programme to reach its main long-term goal of delivering electricity from fusion. These doubts are shared by the Commission.

The strategy for fusion research in the EU is currently set out in the EUROfusion roadmap, which was published in 2012 and updated in 2017. This roadmap, based on the sequential development and exploitation of JET⁴, ITER⁵ and DEMO⁶ facilities, is considered overly complex with an unrealistic timeline. The main concern is that the ITER organisation is currently re-examining the project baseline, which may result in a 10-year delay to the first experiments and leave the industrial supply chain idle. The second concern is the lack of focus on addressing the critical key enabling technology gaps for the development of fusion power reactors, such as radiation resistant materials, breeding blankets and the tritium fuel cycle, plasma heating technologies and advanced magnet systems for improved plasma confinement. This concern is aggravated by the lack of specialised facilities for testing and the qualification of components in a relevant fusion environment. A further concern is that the costs of a first fusion power plant have not yet been quantified and are probably very high. Although EUROfusion is an impressive collaborative effort from the European laboratories, risks and uncertainties in their respective missions have not been fully assessed or quantified. Significant technological challenges remain and it is currently unclear how much time and resources will be required to resolve the issues.

The fusion landscape is changing fast, becoming more dynamic thanks to several private initiatives in Europe and worldwide. There is a significant risk that EUROfusion, as a co-funded public-public partnership, may fail to systematically include these dynamic developments. EU fusion engineering knowledge and industrial potential, developed over decades with significant public investment, might be lost and move to countries outside the EU with a more favourable economic and regulatory landscape.

There is a growing consensus, notably captured at events⁷ and in a public consultation organised by the Commission in 2024, that Euratom's approach today to fusion development should move away from seeing ITER and other initiatives in a sequential way. There is deemed to be an urgent need to develop an EU strategy that provides the right conditions and proper framework to address the technological bottlenecks on the path to the commercial deployment of fusion energy.

3.7. Efficiency and simplification

The interim evaluation shows good overall efficiency in the Commission's management and implementation of the programme. For indirect actions, the administrative expenditure is at 5.4%, below the 6% ceiling set in the Council Regulation. Due to the staff cut of 20% resulting from the programme's budget cuts, the JRC has implemented efficiency measures in the existing research areas. These are reflected in a new strategy for the nuclear activities and

⁴ The Joint European Torus, <https://euro-fusion.org/devices/jet/>

⁵ <https://www.iter.org/>

⁶ <https://euro-fusion.org/programme/demo/>

⁷ High-Level Roundtable on Fostering Innovation for Fusion Energy in Europe (14 March 2024) and 'EU blueprint for fusion energy' expert meeting (23 April 2024)

management of its infrastructure. The programme is doing well on its performance metrics. Average time-to-grant is 230 days, similar to Horizon Europe and an improvement over the 2014-2020 programme (238 days) and the 2007-2013 programme (313 days).

To simplify implementation, the programme relies on the rules and measures for Horizon Europe. The introduction of simplified cost options under Horizon Europe, in particular optional unit costs for personnel, brings further simplification and helps to reduce errors. Unit costs for personnel could already be used for new grants from the 2023-2025 call. Other measures, such as a single, simpler corporate approach for charging personnel costs and the shift of Horizon Europe's control strategy towards identifying and addressing high-risk areas, could reduce irregularities and facilitate the work of beneficiaries.

3.8. Relevance and added value

With the accelerating development and expanding use of nuclear technologies worldwide, the Euratom programme provides the knowledge and solutions needed to benefit from these advancements, and to address societal concerns about radiation risks. Thematic evaluations confirmed the relevance of the current Euratom actions in their fields. However, they also emphasised the need to advocate for improvements to the organisation and operation of co-funded European Partnerships to ensure that the research remains relevant and that it addresses the most pressing challenges. According to the evaluations, the JRC's scientific and technical expertise to the Commission and Member States, as well as the use of specialised tools and facilities, helps to strengthen the safe and secure use of nuclear technologies.

Embedded budget flexibility and some unspent ITER funds and non-EU country credits from the 2014-2020 programme enabled the current programme to tackle new challenges, such as energy security (alternative fuel for VVER reactors⁸) and strategic autonomy in nuclear materials and data, and to support researchers in Ukraine. While the Council Regulation provides flexibility in terms of implementation modes and instruments, the main limiting factor today is the small budget, aggravated by the lack of third-party income as no association agreement has so far been concluded with either Switzerland or the UK. The association of Ukraine to the Euratom programme has strong scientific and political value but no significant budgetary impact. The JRC direct actions provide tools that can be activated and redirected quickly, such as the tool for the diagnosis and prognosis of hazards in nuclear emergencies (DAPHNE), which has been used in Ukraine to assess radiological risks for nuclear power plants under wartime conditions.

The evaluation clearly shows the EU added value of the programme, namely the joint development of knowledge on various applications of radiation and reducing risks. Subsequent public consultations show that the main added value for researchers includes better sharing of knowledge and best practices across borders, greater cross-border collaboration and mobility, and wider dissemination of results.

3.9. Coherence and synergies

The Commission aims to increase consistency between the programme and other EU programmes. Internally, DG RTD and the JRC work closely to coordinate the indirect and direct

⁸ Series of pressurized water reactor designs originally developed in the Soviet Union, and now Russia. Twenty Russian-designed VVER reactors exist in the EU (Bulgaria, Czechia, Finland, Hungary and Slovakia) and fifteen in Ukraine.

actions, for example, by co-drafting the work programmes. Consistency with ITER and Member States' fusion strategies is assured by coordination between DG RTD and DG ENER, supported by the Fusion Expert Group⁹. The programme's partnerships support Member States in implementing the Euratom Directives on Basic Safety Standards and on Radioactive Waste and Spent Fuel Management. The JRC participates in 47% of the project consortia funded by the Euratom grants, providing expertise and access to specialised research infrastructure. This ensures synergies with research organisations and academia across the nuclear field. Synergies with Horizon Europe include MSCA postdoctoral fellowships for nuclear researchers funded by Euratom. The evaluation indicated that further synergies, in particular in non-power applications of ionising radiation, could be much better harnessed if the budget were increased and joint actions with Horizon Europe were easier to implement.

4. CONCLUSIONS

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 and security, the safe management of radioactive waste and radiation protection. They also bring the EU closer to achieving 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 standards. The public also stands to benefit from Euratom-funded research on other applications of ionising radiation, in particular in medicine.

The Council's decision in 2021 to reduce the budget for the programme by 20% 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.

This evaluation provided the important findings described below for the Commission proposal for the extension of the Euratom Programme for 2026-2027. These include:

- The programme addressed new challenges such as research on alternative fuel for Russian-designed reactors used in some Member States, increased strategic autonomy in nuclear materials and data, and support for researchers in Ukraine. The results of the call for innovative applications of ionising radiation show a high interest within medicine, the circular economy, space exploration and environmental monitoring, which could be developed further in synergy with Horizon Europe. These new actions attracted newcomers. However, the limited budget, together with the need to maintain the programme's focus on the core activities of nuclear safety, radioactive waste and radiation protection, means that there will be very limited possibilities to continue funding these new actions in 2026-2027.

⁹ Commission expert group on fusion research and development, for more details see <https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupId=3929>

- The programme’s implementation relies on Horizon Europe’s rules and measures. The public consultation showed that the programme’s beneficiaries are largely satisfied with the current instruments, practices and support received from the Commission. The Commission will continue to simplify in 2026-2027 while ensuring continuity in the application of the rules.
- The evaluation concluded that maintaining the same programme scope and budget for fission research as for 2021-2025 would provide continuity in research for the safe operation of existing nuclear power plants in Europe and for the safety assessment of new reactor technologies. However, funding for research projects in this area will be highly selective as most of the fission budget will be absorbed by co-funded partnerships. Nor will the present scope and level of funding be sufficient if Europe wants to: (i) catch up with international competitors; (ii) address key issues for the development of SMRs, advanced fuels and fuel cycles; and (iii) substantially increase nuclear skills in the EU.
- The programme should continue to provide funding in 2026-2027 for the co-funded European Partnerships in fission research: PIANOFORTE (radiation protection), EURAD-2 (radioactive waste management) and Connect-NM (nuclear materials). These partnerships 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 will push to further improve the organisation and operation of the partnerships to ensure that the research funded by the Euratom programme remains relevant and that it tackles the most pressing challenges. The Commission will pay particular attention to the partnerships so as to systematically consider the long-term perspectives of a broad range of stakeholders and Member States.
- The results of Euratom-funded fusion research are impressive, but they are not sufficient to bring fusion energy to the market in time to support the EU’s decarbonisation efforts and to boost competitiveness. Fusion power will only become a reality if based on accurate assumptions about technical complexity and realistic investment in industrial supply chains. The programme must evolve to remove the technological bottlenecks that require additional focus and investment, involve more private financing and industry experience and increase international collaboration with reliable partners where there is a clear added value for the EU. The Commission has already started to prepare a co-programmed European Partnership in this field which will bring together public and private stakeholders. The 2026-2027 actions will pave the way for this partnership and for supplementary innovation actions. A new partnership of this kind also means rethinking the role and activities of EUROfusion, which will play a major part in developing the fundamentals of fusion science. Further details will be provided in the Communication on the EU fusion strategy, which is currently being drawn up.
- The JRC plays a particular role in the programme. Its four nuclear sites have provided expertise and facilities to half of the Euratom research projects launched since 2021. They also carry out their own highly relevant research, deliver training and produce analyses. This benefits Member States and provides policy support to the Commission on the whole spectrum of activities, from nuclear safety to security and safeguards. The evaluation highlighted the efforts to improve the JRC’s overall efficiency, with the introduction of a new way of working based on portfolios. This has led to better integration of scientific activities. It also noted the implementation of a new nuclear strategy to improve

infrastructure management, better cooperate with stakeholders and enhance communication. For 2026-2027, the JRC will continue to address its research challenges on nuclear security and safety, emergency preparedness and strategic energy autonomy, and to contribute to maintaining nuclear expertise in the EU.