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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE
COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE**

Interim evaluation of the Euratom Research and Training Programme 2014-2018

{SWD(2017) 426 final} - {SWD(2017) 427 final} - {SWD(2017) 440 final} -
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1 Introduction

1.1 Purpose of the evaluation

The interim evaluation of the research and training programme of the European Atomic Energy Community 2014-2018 (the ‘Euratom programme’) is a requirement in accordance with Article 22(1) of the Council Regulation¹. The Commission is required to carry out this interim evaluation with the assistance of independent experts selected on the basis of a transparent process. The interim evaluation of the Euratom programme covers the achievements and results of the programme, progress and impact. The evaluation also looks at the objectives and continued relevance of all the measures, the efficiency and use of resources, the scope for further simplification, and European added value. In accordance with Article 22(2) of the Regulation, direct and indirect actions are the subject of separate evaluations. For this reason, two Commission groups of independent experts (CEG), one for indirect and another for direct actions, were set up in 2016. They submitted their reports to the Commission in May 2017. The present Commission report sets out the findings and recommendations of these groups and the Commission’s observations. In line with ‘Better Regulation’² requirements, the report is accompanied by two staff working documents for direct and indirect actions which present a fuller assessment of the activities of the Euratom programme.

While the Horizon 2020 framework programme for research and innovation covers a seven year period 2014-2020, the Euratom programme has a duration of only 5 years (2014-18) because of the limit set in Article 7 of the Euratom Treaty. To continue supporting nuclear research for the remaining 2 years of the present financial framework, the Commission has adopted together with this report a proposal for a Council Regulation for the Euratom research and training programme for 2019-2020 (COM(2017) 698 final).

1.2 Euratom research and training programme (2014-2018)

The Euratom programme funds research and training in nuclear safety and security, radiation protection, radioactive waste management and fusion energy. The programme is implemented through direct actions in fission — i.e. research performed by the Commission’s Joint Research Centre (JRC), and indirect actions in fission and fusion — i.e. via competitive calls for proposals (fission safety, waste management and radiation protection), and a comprehensive named-beneficiary co-fund action (fusion energy) managed by the Commission’s Directorate-General for Research & Innovation (RTD).

Euratom fission research falls under both direct and indirect actions, while all Euratom fusion research falls under indirect actions managed by RTD.

The 2014-2018 Council Regulation provides a budget of EUR 1 603 329 000 for the implementation of the Euratom programme. This amount is distributed as follows:

- indirect actions for fusion research: EUR 728 232 000
- indirect actions for fission, safety and radiation protection: EUR 315 535 000
- direct actions for fission safety, safeguards and security: EUR 559 562 000.

¹ Council Regulation (Euratom) 1314/2013. The Euratom programme complements the Horizon 2020 framework programme for research and innovation.

2 Key findings on the Euratom research and training programme (2014-2018)

2.1 Programme relevance

Indirect and direct actions of the Euratom programme address research challenges relevant for future economic development and the safety and wellbeing of European citizens. For the actions to continue to be relevant, work programmes are developed in close consultation with Member States. The Commission, represented by JRC and RTD, is a member of several European technological platforms and associations to ensure that the Euratom programme is in line with the needs of relevant research and industry players in Europe. To ensure that direct actions are in line with and complement the research and training needs of Member States, JRC is continuously interacting with the main research and scientific institutions in the Member States. Regarding nuclear safeguards in particular, JRC is a member of the European Safeguards Research and Development Association (ESARDA)³. At international level, the Euratom programme supports the role of the EU as a global player in the field of nuclear safety, safeguards and security through agreements with international organisations and 3rd countries.

Indirect actions

Euratom fusion research focuses on the long-term challenge of developing magnetic-confinement fusion energy as a safe and secure carbon-free base-load source of electricity that is both sustainable and competitive. This is a Europe-wide endeavour with strong international cooperation links, especially in view of the importance of the global ITER project. Since commercialisation of fusion energy is not expected until the second half of the century, most of the financial support today currently comes from public funds. This is reflected in the fact that the fusion part of the Euratom programme accounts for 70 % of the budget for indirect actions.

In ‘fission’ research, more than two thirds of resources have been assigned to three main fields of research, namely nuclear safety, radiation protection and radioactive waste management. The remaining part of the resources has been assigned to research infrastructures and education & training. The programme provides a balance between support for the safety of current and future nuclear technologies. Euratom waste management projects help in better understanding issues relevant to the effective management of radioactive waste in the EU, such as the safety of future geological disposal facilities, the conditioning of radioactive waste, the long-term behaviour of spent fuel in a repository and the clean-up of decommissioned sites. Euratom research on radiation protection will lead to improved knowledge of the effects of low doses of ionising radiation on the human biota, which will translate into a more effective and safer use of radiation and radionuclides in medical diagnostic and therapeutic practices.

With regard to the programme's relevance, the possible areas of improvement for indirect actions as underlined by the CEG include: increasing synergies between radiation protection research associated with medical exposure and health research supported under Horizon 2020, and setting more specific objectives for education and training actions in the nuclear field⁴.

³ <https://esarda.jrc.ec.europa.eu/>

⁴ Detailed information on specific areas of improvement is provided in section 3 and 4 of this report.

Direct actions (JRC)

The nuclear research activities carried out by JRC help to improve nuclear safety, security and safeguards in Europe and globally. They are designed to complement the activities developed either by Member States or under indirect actions and provide an independent scientific basis for EU policies. JRC is also an important provider of nuclear references materials and data. JRC supports the development and maintenance of nuclear skills and competences in Europe through dedicated training in nuclear safety, security, safeguards and non-proliferation. JRC's unique nuclear facilities are open access for use by European researchers and young scientists.

The activities also support the implementation of Council directives and conclusions on nuclear safety, waste management and radiation protection and give priority to the highest standards for nuclear safety in the Union and internationally. JRC is also providing support to the Commission for the implementation of the Euratom nuclear safeguards system in Europe. The JRC helps to improve nuclear security in Europe by supporting EU Member States with nuclear detection technologies and nuclear forensics. Dedicated training is provided to Member States' officers and experts at the JRC nuclear training facilities.

2.2 Programme effectiveness

Evidence from 3 years of Euratom programme implementation (2014-2016) indicates that progress is being made in delivering on all Euratom objectives in direct and indirect actions as set by the Council Regulation⁵.

Indirect actions

In fusion research, the Euratom programme has contributed to some progress in all roadmap missions aimed at demonstrating the feasibility of fusion as a future energy source. This progress has been achieved thanks to the new organisational structure established in 2014 involving all national fusion labs in Europe. This EUROfusion consortium receives co-fund support from the Euratom programme (EUR 316 million during 2014-2017⁶) for implementing a joint programme in line with the European fusion roadmap, based on shared planning and exploitation of research infrastructures, mobility of researchers, and competitive allocation of funds.

On fission research, 48 projects⁷ have been launched following the two competitive calls for proposals (2014/15 and 2016/17) with a EUR 199 million contribution from Euratom. The projects selected for funding address specific objectives set out in the Council Regulation. Data available for the nuclear safety projects launched since 2014 indicate that progress is generally as expected with most deliverables and milestones being achieved. Output from projects in the other technical areas also indicates that the Euratom programme is delivering, even though delays were encountered in the case of a few projects. These were delays due to the nature and unpredictability of cutting-edge scientific research, in particular the unavailability of key and often unique research infrastructures.

Direct actions (JRC)

JRC activities on the safety of current nuclear reactors include helping to develop codes, standards and test methods for reactor materials and software tools for accident modelling and management. These activities also support the assessment of ageing of nuclear power plants for their long-term operation.

⁵ For more details see accompanying Staff Working Documents

⁶ Budgetary commitments, payments amount to EUR 207 million

⁷ Including 2 projects addressing cross-cutting issues in fission and fusion research (materials research and tritium management).

The research on nuclear fuels provides tools and data for the safety analysis of fuel behaviour to understand better fuel performance during normal and incidental conditions. Underpinning and applied research on the safety of fuels for Generation-IV systems is carried out. Having a well-established programme on the nuclear safety of advanced nuclear technologies is important if the EU is to maintain its leading role in promoting globally the highest standards in nuclear safety and security.

For radioactive waste management, JRC provides technical support to implement the Directive on nuclear waste and spent fuel management, reviewing the national programmes and national reviews and contributing to the development of an inventory report of spent fuel and radioactive waste.

For nuclear emergency preparedness and environmental monitoring, JRC activities include the harmonisation of measurements of radioactivity carried out by national laboratories and the related training of personnel to ensure a coherent monitoring programme across Europe. This also supports the Member States in fulfilling their obligations to provide information on radioactivity levels in the environment.

The Commission's activities on nuclear safeguards support the EU's strategic objective to reduce the risk of nuclear proliferation. For this, JRC provides the necessary technical support and related training courses for Euratom inspectors to ensure an effective implementation of EU safeguards systems. Similar support is provided to the IAEA through the Commission's safeguards support programme. The Commission, through the JRC, is one of the main players in developing a strong international safeguards regime.

JRC also carries out dedicated activities on nuclear non-proliferation focused mainly on concepts and methodologies in areas such as open source information collection, strategic trade analysis and studies on export control of dual-use goods. These activities, developed to serve EU policies, are also supporting the IAEA and the global non-proliferation regime.

Direct actions in the field of nuclear security focus on detecting and responding to the illicit trafficking of nuclear and other radioactive materials. JRC's capability in this area, and its support to nuclear security through related scientific and technical expertise, is in high demand by several Member States and international organisations.

JRC produces and supplies state-of-the-art nuclear reference materials and measurements, conformity assessment tools, and nuclear training and education in all its areas of activity.

In the area of education and training, JRC provides nuclear courses and hands-on vocational training for professionals and students in Member States and Commission departments. Moreover, the JRC allows open access to its nuclear research infrastructures and offers complementary research possibilities to external users from EU Member States e.g. through its EUFRAT open access pilot project.

2.3 Programme efficiency

The interim evaluation shows a good overall level of efficiency in the Commission's management (e.g. grant management and proposal evaluation for indirect actions) and implementation of the programme.

Indirect actions

The Commission is keeping its own administrative expenditure for indirect actions below the target of an average of 7 % of the operational budget for 2014-2018 and remains confident that the planned target of 6 % for 2018 will be met. Simplification measures introduced since the start of the programme have greatly improved efficiency, notably for the time-to-grant (TTG). The average TTG

for the Euratom 7th Framework Programme (FP7) was 315 days, whereas it was 261 days for the 23 projects launched following the 2014-2015 call, and decreased further to only 229 days for the 25 projects from the 2016-17 call.

Direct actions (JRC)

Since the beginning of the Euratom sixth framework programme (FP6), the JRC introduced a corporate-wide yearly review to evaluate the previous year's results. The exercise assesses two aspects: productivity defined as the number of outputs delivered, such as the number of times technical support was provided for policies, and the number of scientific publications. The second aspect concerns the impact of the policy support, which is predefined according to a generic set of impact indicators. The results of this evaluation are essential data for deciding the priorities and strategic alignment of the work programme.

Although the number of policy support outputs delivered cannot be easily benchmarked with another comparable institution, the importance and the quality of the JRC scientific achievements/outputs were recognised and underlined several times by the Commission expert group that carried out the interim evaluation of direct actions. Remarks such as '*comparable with more advanced research teams*', '*achievements comparable with the best in class*' and '*worldwide leadership*' were typically used by the expert panel to characterise the quality and performance of the work done.

In the period 2014-2016, a large number of outputs (678 reports, 68 technical systems, 117 training sessions, ...) were delivered to specific users, in support of EU policies. These outputs resulted in the provision of support to EU policies (137 impacts acknowledged), ad-hoc support (10 impacts), support to specific countries or international bodies, mainly IAEA (79 impacts) and 43 contributions to standardisation and harmonisation.

In 2014-2016, the programme's direct research activities produced 658 scientific publications in peer reviewed journals of high reputation, and, in addition, 9 books, 157 articles contributing to monographs and other periodicals, and 15 PhD theses were also completed. A bibliometric analysis⁸ was carried out for the period 2007-2015, focused on peer-reviewed items and based on widely accepted impact metrics. It showed that the performance of JRC's research publications on nuclear science and technology is well above average; hence JRC ranks well among peer organisations.

JRC's participation in the programme of indirect actions helps to improve the interaction with Member State organisations and ensure better alignment with their needs and priorities. This also ensures that both parts of the Euratom programme are relevant and more effective. A clear example is the synergies obtained between the direct research projects on advanced nuclear systems and JRC's participation in indirect research in this field. JRC provides additional in-kind contribution to these projects and is instrumental for the effective representation of Euratom in the Generation IV International Forum, where JRC is the Euratom implementing agent.

2.4 Programme Coherence and EU added value

The Euratom programme is coherent internally and with the other EU programmes and policies. Regarding internal coherence, the Commission ensures links between fission and fusion research by supporting projects addressing topics relevant for both fields such as materials research and tritium management. Synergies between direct and indirect actions are ensured by participation of JRC's institutes in consortia implementing indirect actions' projects, where they provide access to research infrastructures. Regarding coherence of the Euratom programme with other EU programmes and

⁸ Bibliometric analysis of the research performance of the JRC under the Euratom research and training programme (2007 - 2015), JRC 103578.

policies, through the cooperative research, the Euratom programme enables a Europe-wide approach to improving nuclear safety and radiation protection in all areas of application, which complements implementation of the Euratom Directives on nuclear safety⁹, radioactive waste management¹⁰ and basic safety standards¹¹. Possible areas of improvement include the need to exploit synergies with other thematic areas of Horizon 2020 in order to address cross-cutting aspects such as health and energy systems. The Commission also notes the need to seek synergies in application of some Horizon 2020 instruments in nuclear field such as Marie Curie Skłodowska Actions.

A key part of the added value of indirect actions is the Euratom's ability to mobilise a wider pool of excellence, expertise and multi-disciplinarity in nuclear research, than is possible at the level of individual Member States. This is demonstrated by a diverse portfolio of 22 projects launched in 2014-2017 addressing important aspects of nuclear safety (for example accident tolerant fuels, core monitoring techniques, assessment of structural integrity of NPP elements, ageing management etc.) as well the launch of the European Joint Programmes in fusion and radiation protection research. Another example is a joint exploitation of fusion research infrastructures, in particular JET, which rely on the collective endeavours of researchers and engineers from all across Europe (about 350 persons per year), supported by Euratom funding for mobility. This broad-based coordination throughout Europe of education and training, the use of research facilities and international cooperation is of particular benefit to smaller Member States, which can take advantage of the economies of scale afforded by the Europe-wide pooling effect – in fusion research this is exemplified by smaller laboratories that can specialise in scientific topics or subsystems for fusion research facilities in Europe and make important contributions while maintaining visibility in the European consortium.

With regard to JRC activities, the following can be highlighted:

- The scientific and technical support provided by JRC to other Commission departments to prepare, implement and monitor EU policies is provided thanks to in-house expertise developed through the direct research of the Euratom programme.
- JRC helps to develop necessary nuclear knowledge and expertise used by the Commission to fulfil its legal obligations and competences in fields such as nuclear safeguards, safety, waste management and monitoring and measurement of radioactivity on the environment.
- JRC provides support for standardisation, open access for EU scientists to unique nuclear facilities, training activities in fields such as safeguards, nuclear forensics or decommissioning, and the operation of the Clearinghouse on Operational Experience Feedback¹², all of which could not easily be carried out elsewhere.
- JRC coordinates the European research effort on advanced reactor technology, through Euratom membership of the Generation IV International Forum, covering contributions from direct and indirect actions as well as from Member States.

⁹ Council Directive 2009/71/Euratom of 25 June 2009 and its revision 2014/87/Euratom, establishing a Community framework for the nuclear safety of nuclear installations.

¹⁰ Council Directive (2011/70/Euratom) of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

¹¹ Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation.

¹² <https://clearinghouse-oef.jrc.ec.europa.eu/>

3 Recommendations by the Commission expert group for indirect actions and Commission response

This section provides the response to the recommendations addressed to the Commission by the CEG for indirect actions. The information and views set out in the CEG report are those of the authors and do not necessarily reflect the official opinion of the Commission.

Recommendation 1 on the programme's excellence and inclusiveness: *For future Euratom programmes the Council should recognise that even if the level of excellence remains the key for applying for research funding, the dominance of the established organisations can lead to the exclusion of emerging contributors who have the potential to provide new ideas and innovation. Hence consideration should be given as to how this source of innovation can be captured rather than lost from European programmes.*

The Commission agrees with the spirit of the CEG recommendation while emphasising that it concerns a generic issue affecting all research funding programmes, including at EU level. The dominance of incumbents and the potential difficulty for smaller players to obtain funding are a concern also in Horizon 2020, though the latter programme has many more calls and options (e.g. specifically for small and medium-sized enterprises) than is possible in the much smaller Euratom programme. However, data on participation show that the fission programme still manages to attract a significant number and variety of players. A further obstacle in the case of nuclear research is the high cost and complexity of research facilities, which may bias participation in some fields toward the larger incumbents. For this reason, the Commission pays particular attention to supporting the access of all researchers from across Europe to key nuclear research facilities. Nonetheless, the Commission also remains committed to maintaining scientific excellence as a key factor for granting financial support under the Euratom programme. The Commission also observes disparities in the level of participation of Member States in the fission projects supported by the programme. This is particularly the case with Member States that joined in 2004 or later, although to a lesser extent than in other areas of Horizon 2020. To improve this situation, in 2015 the Commission supported projects involving regional initiatives aimed at nuclear research and training capacity-building.

On the fusion programme, one of the conditions imposed by the Council before establishing EUROfusion was to safeguard the level of participation of all fusion labs in Europe, in particular the smaller ones in the new Member States. Though this was intended as a temporary 'safety net' to give labs time to adjust to the requirements of the joint programme (e.g. more focus on technology-related tasks), the information from EUROfusion shows that most of the smaller labs have been more than capable of maintaining a presence alongside the bigger national programmes. Many have even benefited from the new structure by increasing their share of the overall effort and the available Euratom funding. However, it should be understood that the distribution of research and other tasks within the joint programme is the exclusive responsibility of EUROfusion in line with the Consortium Agreement. It is based on a system of internal calls for participation issued to all beneficiaries and linked third parties, and this arrangement will need to come increasingly under the spotlight in future Euratom programmes to ensure it remains fit for purpose during a more formal 'DEMO' CDA (conceptual design activity), particularly if there is to be more participation by industry.

Recommendation 2 on the co-funding rate: *For post-2020 Euratom programme the Commission should review the impact of 100 % funding on the level and scope of research being delivered.*

Euratom programme is implemented on the basis of the Horizon 2020 rules for participation. As a result of these rules, the average funding rate in the current Euratom programme (fission indirect actions) is 76 %, whereas in the 7th Euratom framework programme (FP7) it was 56 %. This would

suggest that in the current Euratom programme, the Commission is reimbursing a higher percentage of the total project costs than in the past, with less leverage to attract co-funding from national programmes and industry. However, such a comparison is misleading because it does not consider the different treatment of indirect costs in each programme. The Euratom contribution is now based on a single reimbursement rate of direct costs (100 %, or up to 70 % for innovation and programme co-fund actions) and a single flat rate of project indirect costs (25 % of direct costs). However, in FP7, direct costs were reimbursed based on a matrix of organisation categories and activity types. There were four different methods of calculating indirect costs, which included ‘real’ (i.e. actual) indirect costs that were usually substantially higher than the current 25 % flat rate. Calculations by the Commission show that once the indirect costs are taken into account, the total funding rates in the current Euratom programme and in FP7 are substantially similar. This recommendation will be further analysed in the impact assessment of the Euratom programme (post-2020) under the next multiannual financial framework.

Recommendation 3 on JET¹³: *In view of the importance of JET for ITER the JET campaigns should be extended up to 2024.*

The current Euratom Programme provides financing for JET via a bilateral contract with the Culham Centre for Fusion Energy which will expire at the end of 2018. The financial envelope for support to fusion research for the period 2019-2020 will need to be decided by the Council when adopting the regulation extending the current programme. All decisions concerning the funding of concrete fusion activities, are to be taken by the Commission as part of the Euratom work programme 2019-2020, once the new regulation is adopted. Any future Euratom support to fusion research and Euratom support to all relevant research facilities beyond 2020 will be the subject of an impact assessment accompanying the Commission proposal for the future Euratom research programme.

Recommendation 4 on DEMO preparations: *EUROfusion should not delay the DEMO CDA and should start the DEMO EDA around 2025 in order to maintain the industrial know-how generated by the ITER construction.*

Recommendation 5 on the fusion roadmap: *EUROfusion to maintain the original roadmap focus on DEMO as an ITER-like tokamak to be built as soon as ITER achieves the $Q=10$ target.*

Recommendation 6 on education in fusion: *EUROfusion should use its educational resources to promote educational programmes that will deliver the nuclear engineers and technologists as foreseen in the roadmap.*

The three recommendations above are addressed principally to EUROfusion, and the Commission will interact directly with EUROfusion to ensure they are addressed to the extent possible. On Recommendation 4 in particular, the Commission agrees that the ‘DEMO’ engineering design phase and formal EDA (engineering design activity) should start as soon as possible to benefit from the momentum to reach ITER ‘first plasma’ and therefore capitalise on the industrial involvement and experience acquired in ITER’s construction.

Recommendation 7 on funding for the mobility of researchers: *EUROfusion and the Commission should review the impact of unit costs on mobility and make any necessary changes.*

The Commission is interacting directly with EUROfusion on this issue. Following a request from EUROfusion, the Commission has already approved an amendment to the grant agreement on the use of unit costs. The Commission will continue to adapt the rules to the evolving needs of EUROfusion.

¹³ The Joint European Torus, <https://www.euro-fusion.org/jet/>

Recommendation 8 on launching the European joint programme (EJP) in waste management research: *For Euratom work programme 2018 or the extension of Euratom programme 2014-18 the Commission and Member States should carefully consider if there is sufficient evidence to demonstrate that the EJP instrument can be applied to research on the geological disposal of radioactive waste at this point in time.*

This recommendation is based largely on feedback received by the CEG in 2016 from the on-going JOPRAD project¹⁴. The Commission has already sought reassurances from participants in JOPRAD and from the Member States on the maturity of the proposed action. As a result, the Commission is now satisfied that, in the period since the CEG made its assessment, the preparations within JOPRAD for an EJP have made substantial progress and there is sufficient evidence, and support from Member States, to proceed. The Commission acknowledges that the EJP is a new funding instrument and that experience to date in Member States is relatively limited. For this reason, the Commission encouraged fruitful exchange between JOPRAD, CONCERT and EUROfusion, which has by far the greatest experience in the use of this joint programming instrument.

Recommendation 9 on specific objectives for education and training: *For the implementation of future Euratom research and training programmes the Commission should ensure that there are specific objectives for the delivery of education and training in the work programme.*

The Commission is already taking steps to address this recommendation. In the 2018 Euratom work programme, the Commission is proposing that for each research action at least 5% of the total action budget must be dedicated to education and training activities for PhD students, postdoctoral researchers and trainees supported through the action. Furthermore, in the case of dedicated education and training actions, projects will be required to provide quantitative information on the number of persons benefitting from the education and training schemes. In the longer term the Commission will aim to develop more comprehensive actions for maintaining and developing nuclear skills in Europe, ensuring at the same time synergies with the EU framework programme's actions supporting education and training.

Recommendation 10 on synergies between Euratom radiation protection research and the Horizon 2020 health programme: *The Commission and the Member States should make continued efforts to link future Euratom research programmes in radiation protection associated with medical exposure with other EU medical research programmes.*

To address this recommendation, the Commission will work with research stakeholders and Member States to exploit synergies between Euratom research in radiation protection and medical research carried out in other EU funding programmes. The aim will be to develop joint research actions on radiation protection aspects of medical practices as well as innovative nuclear medicines, including as yet unexploited radioisotopes.

Recommendation 11 on CONCERT — European joint programme in radiation protection research: *The Commission should carry out a review of how CONCERT is working, to satisfy itself that the aims of the European joint programme (programme co-fund action) in relation to the effective and efficient management of research in the field of radiation protection are being delivered.*

The Commission intends to carry out a mid-term review of the CONCERT project in 2018 to assess the progress made.

¹⁴ The JOPRAD project is a Coordination and Support Action funded by the Euratom programme. The goal of JOPRAD is to prepare the conditions for the setting up of a Joint Programme on Radioactive Waste Disposal (<http://www.joprad.eu/>)

Recommendation 12 on management of conflict of interests by EUROfusion: *EUROfusion should put in place explicit provisions to manage conflicts of interest.*

Recommendation 13 project management by EUROfusion: *EUROfusion should continue to strengthen its project management arrangements and ensure that the programme manager is responsible for the implementation strategy.*

Recommendation 14 on DEMO's design authority: *EUROfusion should as a matter of urgency set up the design authority for DEMO.*

Recommendation 15 on the role of EUROfusion's Scientific and Technical Committee (STAC): *EUROfusion should look at ways of reducing the burden on STAC from its role in the project selection process for enabling research.*

The four recommendations above are addressed principally to EUROfusion and have already been raised during the mid-term review of EUROfusion and during the assessment of its management system, both of which were completed in July 2016. Their consideration is currently on-going, and the Commission will monitor this process as part of its routine activities of oversight and management of the Euratom programme.

Recommendation 16 on application of the Marie Skłodowska-Curie (MSCA) scheme to the Euratom programme: *The Council should consider extending the Marie Skłodowska-Curie scheme to Euratom's fission research programmes.*

The Commission is aware that expertise in the field of nuclear science and technology needs to be maintained and will consider all possible ways to ensure access by all researchers, irrespective of the field, to education and training grants. In this context, the idea proposed by the CEG of extending the MSCA programme will be considered in the ex-ante impact assessment of the post 2020 Euratom programme.

Recommendation 17 on coordination between EUROfusion and the 'Fusion for Energy' Joint Undertaking: *To improve the coherence of the research needs of the roadmap the coordination between the top level management of F4E and EUROfusion should be strengthened*

The Commission has already taken steps to address this recommendation by setting up regular meetings between the management of EUROfusion, F4E¹⁵ and representatives of the Commission. Two meetings have already taken place, and the Commission is eager to ensure that they continue to take place approximately every six months. The Commission and the other parties are keen to formalise and strengthen this framework as necessary to provide the appropriate oversight of progress on the roadmap and manage the key areas of joint responsibility between EUROfusion and F4E.

Recommendation 18 on revision of the fusion roadmap: *The Commission should introduce a formal fusion roadmap revision procedure to ensure that any revision to the original fusion roadmap is owned by all relevant stakeholders.*

The roadmap is the fundamental guiding strategy of the fusion research effort in Europe. The strength of this strategy is that the roadmap is approved, or at least accepted, by all players as the most appropriate path to fusion electricity in a realistic yet ambitious time horizon. The Commission is keen to ensure there is continued widespread acceptance of the roadmap in the future, while also understanding that reviews and revisions of the roadmap will remain a feature of the evolving strategy. The present revision, the first in 5 years, is necessary in view of the new ITER baseline, with 'first

¹⁵ Fusion for Energy (F4E) is the Euratom's Joint Undertaking for ITER and the Development of Fusion Energy, <http://fusionforenergy.europa.eu/>

plasma' now 5 years later than planned in the original roadmap. It is also necessary in view of the results of research carried out under the various roadmap missions. Though the present revision was initiated by EUROfusion, this was a transparent process with many other players (including F4E and also industry) involved in the process. The draft revised roadmap was also included in the scope of the mid-term review of EUROfusion in 2016. The revised version retains the same structure (missions, critical path) as the original, while updating the implementation plan in line with the new ITER baseline. Both the EUROfusion General Assembly and the F4E Governing Board are expected to adopt the revision in second quarter of 2018.

4 Recommendations by the Commission expert group for direct actions and Commission response

This section provides the response to the recommendations addressed to the Commission by the CEG for direct actions.

Recommendation 1 on education and training: *The panel recommends that the JRC continues and where possible reinforces its education and training activities. The hands-on practical training and work experience that the JRC offers in its laboratories to students, young researchers, trainees and PhD students is essential to ensure that the next generation of nuclear scientists and engineers in the EU has the necessary skills and knowledge in key areas of nuclear technology.*

The new JRC 2030 strategy¹⁶ was adopted in the spring of 2016; this led to a restructuring of JRC in July 2016 establishing, under the new Directorate for Nuclear Safety and Security, a new unit dealing with knowledge for nuclear safety, security and safeguards.

The CEG remarked that *'The achievements of the JRC in this field (training and education) are probably the best in the world.'* JRC will continue to strengthen its role by providing access to its research infrastructure, disseminating knowledge, offering courses and coordinating knowledge management, education and training in the nuclear field for both Member States and the relevant Directorate-Generals in the European Commission.

An example is the recently launched ELINDER project (European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation) investigating the opportunities to stimulate the development, coordination and promotion of adequate education and training programmes at EU level in nuclear decommissioning. Attention will be paid to a sustainable interaction with interested industrial players. Additionally, JRC is strengthening its collaboration with the European Nuclear Education Network (ENEN).

JRC will continue managing the European Human Resources Observatory for the Nuclear Energy Sector (EHRO-N) and helping to define qualifications in the European credit system for vocational education and training (ECVET). It will continue organising and delivering training courses on nuclear safety, security and safeguards and classroom lectures and involve MSc and PhD students in JRC's research programmes. To strengthen its contribution to European education and training efforts in various fields, and in agreement with its strategy 2030, JRC opens its research infrastructure up to external users through several projects and initiatives.

One example of a course with academic recognition in the area of nuclear safeguards and non-proliferation is the highly successful annual ESARDA course, which will also be exported outside Europe in the coming years.

¹⁶ The European Commission's science and knowledge service: [JRC Strategy 2030](#).

The European nuclear security training centre EUSECTRA is now fully operational and providing support to Member State authorities in the field of nuclear safeguards and nuclear security.

The new Collaborative Doctoral Partnerships initiative is an instrument to establish partnerships with higher education Institutions on specific PhD subjects. This will allow to overcome the challenge of the cancellation of previous grant-holder schemes for PhD students and post-doc researchers, maintaining the same high level of quality in the education and training provided in the past.

Recommendation 2 on communication and reaching out: *The panel recommends that the JRC reaches out to become more visible as a public expert organisation in this field. The JRC knowledge management activities should focus their efforts on good communication of nuclear matters, not only to the nuclear organisations, but also to the other stakeholders, notably the politicians and the general public. De facto the JRC is the voice of the EU in technical matters, and it should be more ambitious in this respect. There is no other body within the EU Institutions that can address the different aspects of nuclear energy with such a high level of expertise and knowledge.*

The new organisation of JRC and in particular the new unit for nuclear knowledge management will support and improve the visibility of JRC nuclear and technical expertise. Its mission is to manage and disseminate knowledge generated by the scientific units of the Nuclear Safety and Security Directorate by mapping, collating, analysing, quality checking and communicating in a systematic and digestible way relevant scientific data, methods, tools. Its job is also to monitor knowledge available worldwide and facilitate open access to JRC nuclear facilities including training and education. Attention will be given to anticipating knowledge needs, mapping knowledge gaps and suggesting research to be carried out by JRC.

Recommendation 3 on programming: *The panel recommends that the JRC should systematically introduce project-management techniques in the implementation of the Euratom programme. The panel found an improved programming; clearer objectives, clearer reporting, but the JRC has not achieved the rigorous programming and execution of its Euratom activities envisaged in the previous evaluations. The JRC should build a project-management culture in order to achieve the greatest impact and ensure maximum efficiency in the programme.*

JRC is introducing project management techniques to manage its work programme. The phases of initiation and planning have already been implemented and are showing results, as the panel acknowledged (clearer objectives, clearer reporting and improved transparency of the programme). After defining its 2030 strategy and modifying its organisation in 2016 to strengthen its governance, JRC is working to better monitor and manage the implementation of the programme execution phase and closing phase of the project management cycle.

The increasing number of JRC staff attending training courses on project management, some of whom are being certified as practitioners, highlights the attention that is being given to further developing a project management culture at JRC .

Recommendation 4 on resources: *The panel recommends that the JRC should establish a detailed documented view of the capabilities, staff resources and infrastructure of its nuclear directorate, with an inventory of its technical teams, the critical limit for the size of each team and the priority class (1, 2, 3) of these teams. All this, to take action to maintain a certain capability or, if needed, to achieve an informed decision on which capability to suppress.*

In September 2016, JRC concluded an assessment of all its research infrastructure and laboratories, including Euratom laboratories. The assessment describes in detail laboratories and research infrastructure, including use, status or refurbishment needs, running and staff costs, the experimental

work carried out, and the strategic plans for the development of JRC infrastructure. The assessment concluded that the development of JRC's research infrastructure needs to focus on optimising the use and complementarity of the facilities. Such development has to respond to the challenges of having the laboratories spread over different sites across Europe optimising the use of resources, maximising the use of laboratories infrastructure, addressing the obsolescence of some of them, maintain state-of-the-art instruments and equipment, increasing synergies, etc. Complying with the nuclear safety and security requirements of the regulatory authorities in the host countries is the underlying utmost priority. A dedicated JRC steering board has been set-up to follow the recommendations of the 2016 review

This study is the basis for building the strategy determining the priorities of JRC research infrastructure and for setting up the teams to run it. It is evidently linked to the priorities established by the JRC strategy, the Euratom programme, and ultimately the Member States. The strategy for further developing the JRC Euratom research infrastructure will take into consideration the diversity of the research infrastructure and the teams. Thus, the future development and upgrade of the infrastructure will be driven by its better integration and optimisation, bearing in mind the complementarity of the different experimental capacities to ensure comprehensive wide-scope nuclear laboratories suitable for carrying out JRC's work programme. The open access dimension and the complementarity with external laboratories in the Member States will be further emphasised.

Recommendation 5 on organisation: *The panel recommends the JRC to introduce a contractual relationship between the programme directorate with its Euratom coordination unit and the nuclear directorate responsible for research implementation to ensure an excellent relation between the two cross-functional parts responsible for the achievement of its Euratom tasks.*

The new JRC organisation chart, published in July 2016 puts together under a single directorate all nuclear activities. Thanks to the new organisational structure, there are now clear links between the Directorate for nuclear safety and security (in charge of executing the work), the Directorate for strategy and work programme coordination (coordinating the implementation of the work programme in agreement with the defined strategy) and the resources Directorate (in charge of providing the necessary resources). A coordination mechanism between the Directorates for strategy and work programme coordination and for nuclear safety and security has been put in place to clearly streamline the role and mandate of each party. Further actions will be considered if needed.

Recommendation 6 on cost effectiveness: *The panel recommends that the JRC should take on the burden of proof of its cost-effectiveness and for a future external assessment provide convincing information that the work is carried out in a cost-effective way*

The JRC acknowledges the recommendation and will work to provide more comprehensive and benchmarked information.

In scientific nuclear research, cost-effectiveness is always difficult to assess, especially for new and cutting-edge research activities, and for complex or long duration projects using one-of-a-kind facilities, as is often the case in the nuclear field. The lack of adequate benchmarking and/or reference options makes it very difficult to quantify cost-effectiveness in a traditional way. Moreover, the impact of the results obtained is often difficult to evaluate within a short period.

Nonetheless, JRC carries out a yearly exercise to evaluate the results obtained in the previous year. The exercise assesses two aspects: productivity in terms of number of outputs delivered for policy support or scientific publications, and the policy support impact generated by the outputs provided and analysed against a predefined generic set of impact indicators. The results of this evaluation are essential data for the basic and mandatory needs of the Commission's strategic programming and

planning cycle. They are also essential for determining the priorities and strategic alignment of the JRC work programme.

The reorganisation of JRC Directorates puts together under a single directorate all nuclear activities. The same goes for most administrative functions (human, financial, logistics, security, etc.) that are grouped under a single directorate. This has allowed efficiency gains by optimising the use of human resources avoiding duplication of functions on the various JRC sites, streamlining of managerial/reporting lines and simplifying key procedures. The assessment of all JRC research infrastructures, identified opportunities for synergies and complementarities and improvements in the management of ICT infrastructure is being realised through a new coherent governance and architecture.

Recommendation 7 on the Euratom programme: *The panel is in favour of a strong Euratom programme to help put Europe at the forefront of nuclear generation and to maintain its technology leadership as proposed in the Energy Union package. The panel recommends that this programme should:*

- a) *Support the EU's need to maintain the capability to manage nuclear safety, security and safeguards by the JRC and the relevant research and training institutions in the Member States.*
- b) *Bring a 'rapprochement' between the direct and indirect actions in fission research, which means that the Commission:*
 - i. *Implements a coherent programming of the two parts with a well-defined governance and decision-making processes, making full use of the competence and the unmatched position of the JRC, which no longer competes for funding under the indirect actions and participates in every project where this has an added value, albeit only for nuclear knowledge-management purposes.*
 - ii. *Proposes in the Euratom extension (2019-2020) one ex-post evaluation of the nuclear fission activities in the programme, to be conducted in 2022.*

For this purpose, the JRC should start preparing a long-term vision for its own activities as part of an integrated, coherent proposal for the direct and indirect actions in the ninth Euratom programme for research and training, coordinated with the Member States and managed consistently by the Commission services.

JRC fully acknowledges the recommendation on having a strong Euratom research and training programme supporting the needs of the EU and Member States. It will continue complying with its mandate which is focused on nuclear safety, safeguards and security, and supporting the implementation of EU policies in these areas.

JRC's work is instrumental in ensuring that the Commission can fulfil its obligations and commitments in the fields of nuclear safety, radioactive waste management, radiation protection, and nuclear security. This is shown by the scientific and technical support JRC provides to implement the Council Directives on nuclear safety (amended in 2014), radioactive waste management, and basic safety standards. It is also demonstrated by the JRC scientific and technical support provided for the EU outreach activities through the implementation of the Instrument for Nuclear Safety Cooperation, and the Instrument Contributing to Stability and Peace.

It should be noted that nuclear safeguards and to some extent nuclear security (nuclear detection and forensics) are areas where JRC's scientific and technical competences have a long-standing international recognition. The JRC is therefore in the best position to continue supporting the Member States and policies, as long as its expertise is preserved and deepened.

JRC also acknowledges the relevance of the recommendation on the need for a coherent and integrated approach to direct and indirect actions. Efforts to strengthen synergies between indirect and direct actions will continue. In recent years, discussions, to ensure the coherence of both types of actions, were held with the Directorate-General for Research & Innovation, responsible for implementing the programme of indirect action. JRC is participating in different ways (boards, working groups,...) in existing European technological platforms which aim to develop a European Research Area. These efforts to strengthen synergies between indirect and direct actions will continue in future in order to ensure consistency and effectiveness across the full Euratom programme.

Recommendation 8 on synergy between nuclear and non-nuclear activities: *The panel recommends the JRC to create more synergy between its nuclear and non-nuclear activities and include the results in its proposals for the next Euratom research programme (2021-2025) and the ninth framework programme. The panel welcomes the intention of the JRC strategy to exploit the potential for knowledge transfers in areas like energy policy, climate change, sustainable development goals (SDGs), security and emergency preparedness. Nevertheless, the panel strongly recommends that the JRC should maintain a clearly defined nuclear part in its work programme.*

The JRC 2030 strategy, published in June 2016 by JRC, defines its vision and mission. Putting high emphasis on breaking down silos between the different strands of JRC scientific expertise. The new JRC strategy is based on three broad dimensions: competitiveness and fairness, which reflect the EU's long-standing aim to create a prosperous social market economy; and resilience, which has become an important issue since the last financial and economic crisis. Within its strategy, the JRC will streamline its activities around ten priorities: (i) economy, finance and markets; (ii) energy and transport (iii) education, skills and employment; (iv) food, nutrition and health; (v) environment, resource scarcity, climate change and sustainability; (vi) people, governance in multicultural and networked societies; (vii) civil security; (viii) migration and territorial development; (ix) data and digital transformations; (x) innovation systems and processes.

In this context more synergy between nuclear and non-nuclear activities and nuclear science applications will be considered for the future in the following areas:

- security of energy supply — loss of considerable part of energy generation capacity in Europe (e.g. political decision, lack of investment framework, Nuclear Power Plant ageing)
- financing of the back-end of nuclear fuel cycle (risk profiles of funds)
- public involvement in decision-making
- security of supply of medical radioisotopes — economic structure of the market, long-term investments in new production facilities, full-cost recovery
- nuclear sciences applications in support of the sustainable development goals.

5 Conclusions

The interim evaluation concluded that the Euratom programme is highly relevant across the full scope of activities, including nuclear safety, security and safeguards, radioactive waste management, radiation protection and fusion energy. Action at EU level continues to be instrumental in addressing challenges faced by all Member States in these areas. The Euratom programme ensures that public financing is used in an optimal manner by avoiding unnecessary duplication while providing the required EU-added value, economies of scale, coordination and harmonisation. In this respect, the Euratom programme remains a key part of the European nuclear research landscape.

Given the research results achieved so far there is no need to revise the current programme's activities or mode of implementation for the two years 2019-2020 during which the programme is extended. Therefore, the Commission proposal for a Council Regulation which will extend the Euratom research and training programme to 2019-2020, adopted together with this report, is continuing with the same scope and objectives as in the current Euratom programme (2014-2018), in line with the original seven-year impact assessment.

On the programme's efficiency and effectiveness, the CEG reports indicate some areas requiring action by the Commission and/or beneficiaries. These will be addressed as appropriate over the coming months to optimise programme implementation during the 2019-2020 extension and better prepare for the post-2020 programme. Other recommendations, in particular on the long-term aspects of nuclear research or instruments that the Euratom programme shares with Horizon 2020, will be further analysed in the ex-ante impact assessment of the Euratom programme (post-2020) of the next multiannual financial framework.