



Brussels, 1.12.2017
SWD(2017) 426 final

COMMISSION STAFF WORKING DOCUMENT

**INTERIM EVALUATION OF DIRECT ACTIONS OF THE EURATOM RESEARCH
AND TRAINING PROGRAMME 2014-2018**

Accompanying the document

**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

{COM(2017) 697 final} - {SWD(2017) 427 final} - {SWD(2017) 440 final} -
{SWD(2017) 441 final}

Contents

1. Executive summary	4
2. Introduction	6
2.1. Context and legal basis	6
2.2. Objectives and scope	6
3. Methodology and objectives	10
4. Implementation	11
4.1. Overview of the programme.....	11
4.2. Planning and execution.....	11
4.3. State of play	12
5. Relevance	14
5.1. Relevance of the topics addressed	14
5.2. Relevance to European objectives.....	14
5.3. Relevance to stakeholders needs	14
6. Effectiveness	16
6.1. Outputs delivered	16
6.2. Expected long term results and impacts.....	17
6.3. Success stories	19
7. Efficiency	21
7.1. JRC resources	21
7.1.1. The budget	21
7.1.2. The staff	21
7.2. JRC Euratom research and training programme, productivity and impact	22
7.2.1. Policy support outputs.....	22
7.2.2. Scientific outputs	23
7.2.3. Impact achieved	23
8. Coherence	24
8.1. Internal coherence between areas of the programme	24
8.2. External coherence with main stakeholders.....	24
9. EU added value	26
10. Key findings.....	28
10.1. Relevance	28
10.2. Effectiveness	28
10.3. Efficiency	30

10.4. Programme's internal coherence and EU added value	31
11. Lessons learned – Areas of improvement.....	32
12. Conclusions	33
Annex 1: Procedural information concerning the process to prepare the interim evaluation of indirect actions of the Euratom research and training programme 2014-2018.....	34

1. EXECUTIVE SUMMARY

This Staff Working Document presents the interim evaluation of the direct actions of the Joint Research Centre (JRC) of the European Commission implemented under the Euratom research and training programme 2014-2018¹ (hereinafter the Euratom Programme). It takes into account the external evaluation² conducted by a panel of high-level independent experts between October 2016 and April 2017.

The general objective of the Euratom Programme is to pursue nuclear research and training activities with an emphasis on continuous improvement of nuclear safety, security and radiation protection, notably to potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way. The general objective is implemented through the direct and indirect actions which pursue the specific objectives.

The scope of this interim evaluation encompasses the direct actions of the JRC carried out in the context of the Euratom Programme during its first half, assessing the continued relevance of the programme's objectives, reviewing initial outputs and early impacts of the programme and considering areas for improvement for the remaining part of the programme.

The present document describes how the programme is implemented, showing its structure and explaining the mechanism for adoption.

The evaluation follows the guidelines for Better regulation³, considering the aspects of relevance, efficiency, effectiveness, coherence and EU added value of the work performed under the programme and its follow up for the coming period to the end of it.

The effort carried out to meet the needs of the EU and ensure a global influence is described in this report. The direct actions performed constitute a diverse programme of scientific and technical work, which supports the EU policies, the Commission political agenda and meets EU Member States needs in relation to nuclear safety and security.

The programme is achieving its objectives both by providing scientific and technological support for the EU research and training policies on nuclear safety and security, and also by contributing to improve the nuclear security and nuclear safety in Europe and worldwide.

The efficiency of the direct actions is evaluated against two aspects: the productivity, defined as number of outputs delivered, and the impact provided in support to the EU policies, which is predefined according to a generic set of impact indicators. A bibliometric analysis carried out for the period 2007-2015, showed that the performance of JRC's research publications in the field of Nuclear Science and Technology is well above average, and ranking well amongst peer organisations; the importance of the policy support outputs delivered and its quality were recognised and underlined several times by the expert's panel that carried out the interim evaluation.

The programme shows coherence both, internally and externally. The different parts of the programme are mutually supporting, learning from each other to obtain benefits and synergies. At

¹ Council Regulation (Euratom) No 1314/2013 on the Research and Training programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation

² Commission Expert Group Interim Evaluation of the Direct Actions under the Euratom Research and Training Programme

³ COM(2015)215- Better Regulation Guidelines: http://ec.europa.eu/smart-regulation/guidelines/docs/swd_br_guidelines_en.pdf

the same time the direct actions performed are supporting research programmes carried out under other schemes such as indirect actions and national programmes. The participation in contractual activities complements the tasks outlined in the direct actions and allows the JRC to be firmly integrated in the European research landscape.

The EU added value of the direct actions of the Euratom programme is demonstrated by the following components: it complements national research programmes; it provides essential scientific and technical support to the Commission in the preparation, implementation and monitoring of the EU policies and to fulfil its legal obligations and competences; it supports the standardization, and it provides training in the fields of its objectives. The representation of Euratom in Generation IV International Forum⁴ and the coordination of the Euratom's technical and scientific contribution to Generation IV stem from the Euratom programme direct actions or are funded through its indirect actions, completed with MS direct contributions.

The recommendations received from the external evaluation panel for the reporting period, as well as the actions proposed to address these recommendations are included.

Regarding efficiency and effectiveness of the Programme, the reports indicated some areas requiring some improvement. Some of the recommendations will be implemented during the next two years programme 2019-2010, other will be further analysed.

⁴ Agreement extending the Framework Agreement for international collaboration on research and development of Generation IV nuclear energy systems

2. INTRODUCTION

2.1. Context and legal basis

This Staff Working Document presents interim evaluation of the direct actions described on the Euratom research and training programme (2014-2018) implemented by the Joint Research Centre (JRC) of the European Commission. It takes into account the external evaluation conducted by a panel of high-level independent experts between October 2016 and April 2017.

The Joint Research Centre supports the Commission in fulfilling the obligations set up by the Euratom Treaty in the areas of nuclear research and training. The JRC's nuclear research activities, for the period 2014-2018, are defined in the Euratom Programme. It also contains the provision for an interim review in Article 22, which states that by 31 May 2017 the Commission shall carry out an interim evaluation of the Euratom Programme with the assistance of independent experts. The evaluation concerns "the achievements of the programme at the level of results and progress towards impacts, of the objectives and continued relevance of all the measures, the efficiency and use of resources, the scope for further simplification, and European added value".

Specific inter-institutional and Commission requirements further frame this evaluation, in particular, those related to the Financial Regulation (Article 6), the Implementing Rules (Article 27.3)⁵ and the evaluation standards⁶.

For this purpose the panel of experts carried out an evaluation of the quality of the research activities, the programme's implementation and management, and the progress towards the relevant objectives set in the Euratom programme. The final report has been prepared by the panel with conclusions and recommendations as regards the JRC's implementation of its direct actions under the Euratom Research and Training Programme (2014-2018).

2.2. Objectives and scope

General objective of Euratom programme and specific objectives of direct actions

The general objective of the Euratom Programme is to pursue nuclear research and training activities with an emphasis on continuous improvement of nuclear safety, security and radiation protection, notably to potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way. The general objective is implemented through the direct and indirect actions which pursue the specific objectives⁷. The activities of the JRC are developed in full alignment and complementary with the research programmes implemented by various EU MS.

⁵ Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002.

⁶ "Responding to Strategic Needs: Reinforcing the use of evaluation", SEC(2007) 213.

⁷ Council Regulation (Euratom) No 1314/2013. Art 3

The Euratom Programme direct actions have the following specific objectives:

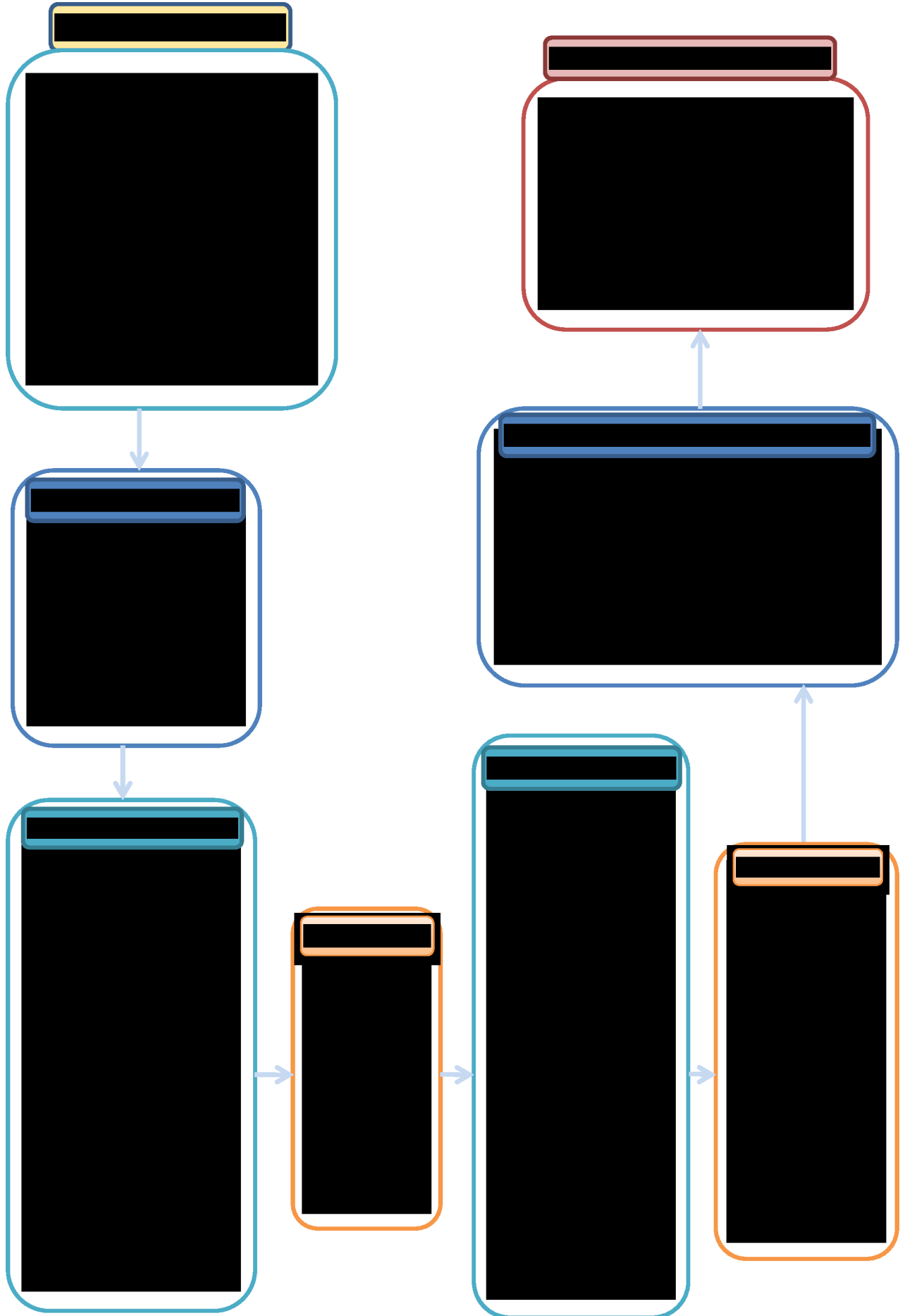
- (a) improving nuclear safety including: nuclear reactor and fuel safety, waste management, including final geological disposal as well as partitioning and transmutation; decommissioning, and emergency preparedness;
- (b) improving nuclear security including: nuclear safeguards, non-proliferation, combating illicit trafficking, and nuclear forensics;
- (c) increasing excellence in the nuclear science base for standardisation;
- (d) fostering knowledge management, education and training;
- (e) supporting the policy of the Union on nuclear safety and security.

The activities to achieve the indicated objectives are described in the annex I of the Euratom programme; they are further developed in the JRC's work programme projects and work packages

The objective of the nuclear activities of the JRC aims at satisfying the R&D requirements in support of both Commission and Member States. This is implemented by developing and assembling knowledge to assure the safety and reliability, safeguards, sustainability and control, and to address the challenges of the nuclear energy production, including the assessment of innovative and future systems.

The following figure shows that the intervention logic of the JRC research and training programme was designed to maximize its impacts:

Intervention logic diagram



Comparison with objectives of FP7- continuity

The JRC's work programme for the period 2014-2016 includes elements of continuity with respect to the previous programme, while aiming at matching new demands arising from the evolution of Member States and global scenarios. It is carrying out nuclear safety, safeguards and security research, aiming to provide improved support to the EU policies, and, at the same time, being a continuation of the FP7 work programme⁸.

The programme on nuclear safety was more focused in severe accident analyses and modelling for assessment of operational safety margins. At the same time, the JRC's work programme is flexible enough to adapt to the needs arising from the EU policies. Examples are the support provided to the implementation of the EU regulations in nuclear safety and waste management.

Decommissioning is an area of research and training that was introduced in the extension programme of FP7 and is now fully integrated in the current programme. JRC has launched recently an important initiative on training in this field involving more than 14 partners in EU MS as well as the European Nuclear Education Network (ENEN) and IAEA.

The demand related to nuclear security-related policies has grown during the recent period. The European nuclear security training centre EUSECTRA⁹ is now fully operational and providing support to the MS authorities in the field of nuclear safeguards and nuclear security. The support to the CBRNE Centres of Excellence¹⁰ project, started already in 2012, which is developing and being extended to new areas following the model, or the support to the implementation of the EU regulations in export control

In the area of standardisation JRC has a clear mandate to investigate fundamental properties of nuclear material and providing standards, reference data and measurements. During the period 2019-2020, this mandate shall be further developed.

The JRC continues to support the policy of the Community to maintain key competences and expertise for the future by giving access to its infrastructures and by training young scientists and fostering their mobility, thus sustaining nuclear know-how in Europe.

The political support dimension is highlighted in the current programme where the JRC provided support mainly to the implementation of the Euratom policies and to MS and international organisations.

⁸ Seventh Framework Programme of the European Atomic Energy Community (Euratom) for nuclear research and training activities 2007 to 2011 (2006/970/Euratom)

⁹ <https://ec.europa.eu/jrc/en/european-nuclear-security-training-centre-eusectra>

¹⁰ <http://www.cbrn-coe.eu/>

3. METHODOLOGY AND OBJECTIVES

The interim evaluation encompasses the direct actions of the JRC carried out in the context of the Euratom Research and Training Programme during the first half of the current programme.

Whilst fulfilling the obligations laid down in the legal basis of the Euratom Research and Training Programme (2014-2018) the objectives of this interim evaluation are:

- to assess the continued relevance of the programme's objectives;
- to assess the efficiency and use of resources, the scope for simplification and the EU added value
- to review initial outputs and the early impacts of the programme, paying specific attention to the quality and the performance level of the various activities carried out by the JRC;

to assist the JRC senior management with specific orientations for the remaining part of the Research and Training Programme. With the expiration in 2018 of the Euratom research programme 2014-2018, the interim evaluation should facilitate upcoming decisions for continuing the programme beyond 2018 and build an evidence base for future impact assessments of nuclear activities of the JRC.

The methodology followed for the evaluation is in line with the better regulation principles. It is analysing the results obtained during the intermediated period of the current Euratom programme, considering:

- its relevance for the European stakeholders: considering the relevance of the original objectives and their evolution.
- the effectiveness of the results obtained: achievement of the objectives and the impact obtained.
- the efficiency on the use of resources: analyses of the number and quality of the outputs delivered in comparison with similar Institutions
- the coherency of the programme both between its different parts and with other European and global research programmes, as well as with EU policies
- the EU added value of the actions carried out: advantages or need of the EU action rather than at MS level

Additional information related to the procedure followed for the evaluation process can be found in Annex 1

4. IMPLEMENTATION

4.1. Overview of the programme

During the evaluated period the JRC addressed several recommendations, identified in the FP7 ex-post evaluation, to improve the internal governance together with the transparency, effectiveness and efficiency of its nuclear activities.

With the aim of increasing the transparency of the JRC work programme, defining more concrete objectives and deliverables, and attributing resources commensurate to priorities, A rolling two-year work programme was developed, defining its "key orientations", which is annually updated. In 2014 the programme was organised in small units of work (work packages) following a series of criteria regarding size, duration, and other requirements. Links among work packages were identified and highlighted to ensure coherence and coordination. The work packages were then grouped in projects, which allow bringing together relevant work packages according to coherent thematic domains.

For the present evaluation, the projects and their work packages, constituting the JRC's work programme are grouped in the following subjects:

1. Nuclear safety	2. Nuclear security
1.1. Nuclear reactor safety	2.1. Nuclear safeguards
1.2. Safety of (conventional and innovative) nuclear fuels and fuel cycle	2.2. Non-proliferation
1.3. Radioactive waste management	
1.4. Nuclear Emergency Preparedness and Response (EP&R)	2.3. Nuclear security and prevention of CBRN hazards)
1.5. Environmental monitoring & radiation protection	
3. Standards for Nuclear Safety, Security and Safeguards	
4. Knowledge management, training and education	
5. Non energy applications of radionuclides and technologies	

4.2. Planning and execution

The development of the JRC's Annual Work Programmes is driven by the outcome of strategic planning workshops and thematic round tables organised by the JRC Director General as well as other JRC senior management meetings to establish the research priorities for the period of interest. The inputs considered are: the objectives defined in the Euratom research and training programme, the Commission's political priorities, the research priorities in the EU Member States and the strategic research agendas of relevant international organisations, the findings and recommendations of the work programme evaluations, the implementation of the JRC Strategy 2030 and the available resources in terms of staff and budget.

An ex-ante assessment of the draft programme is carried out annually, by an internal panel of experts, allowing the JRC's senior management to discuss the work programme's content, priorities, means etc., and take decisions during the planning phase.

After the approval of the final draft, the programme is submitted to the JRC Board of Governors, to have the opinion of the Member States, and to an internal Interservice Consultation to acquire the formal opinion of the concerned Commission Services. A final review takes care of the opinions and comments received, leading to the Work Programme submission for adoption by the Commission¹¹.

Since the beginning of the sixth framework programme (FP6), the JRC introduced a corporate-wide yearly review, nowadays called JRC Productivity and Impact review (PRIME). The goal of the review is to monitor the execution of the work programme providing a traceable internal assessment on the strengths and weaknesses of the JRC scientific activities on a yearly basis.

The results of this evaluation are essential data for the basic and mandatory needs of the Commission's Strategic Programming and Planning (SPP) cycle, JRC and H2020 indicators, as well as for prioritisation and strategic alignment of the JRC's work programme.

The annual exercise assesses the productivity (policy support outputs and scientific publications in peer-review journals), and the policy support impact which the outputs resulted, analysed against a predefined generic set of impact indicators.

4.3. State of play

The analysis of the results obtained against the indicators proposed, bring the following conclusions:

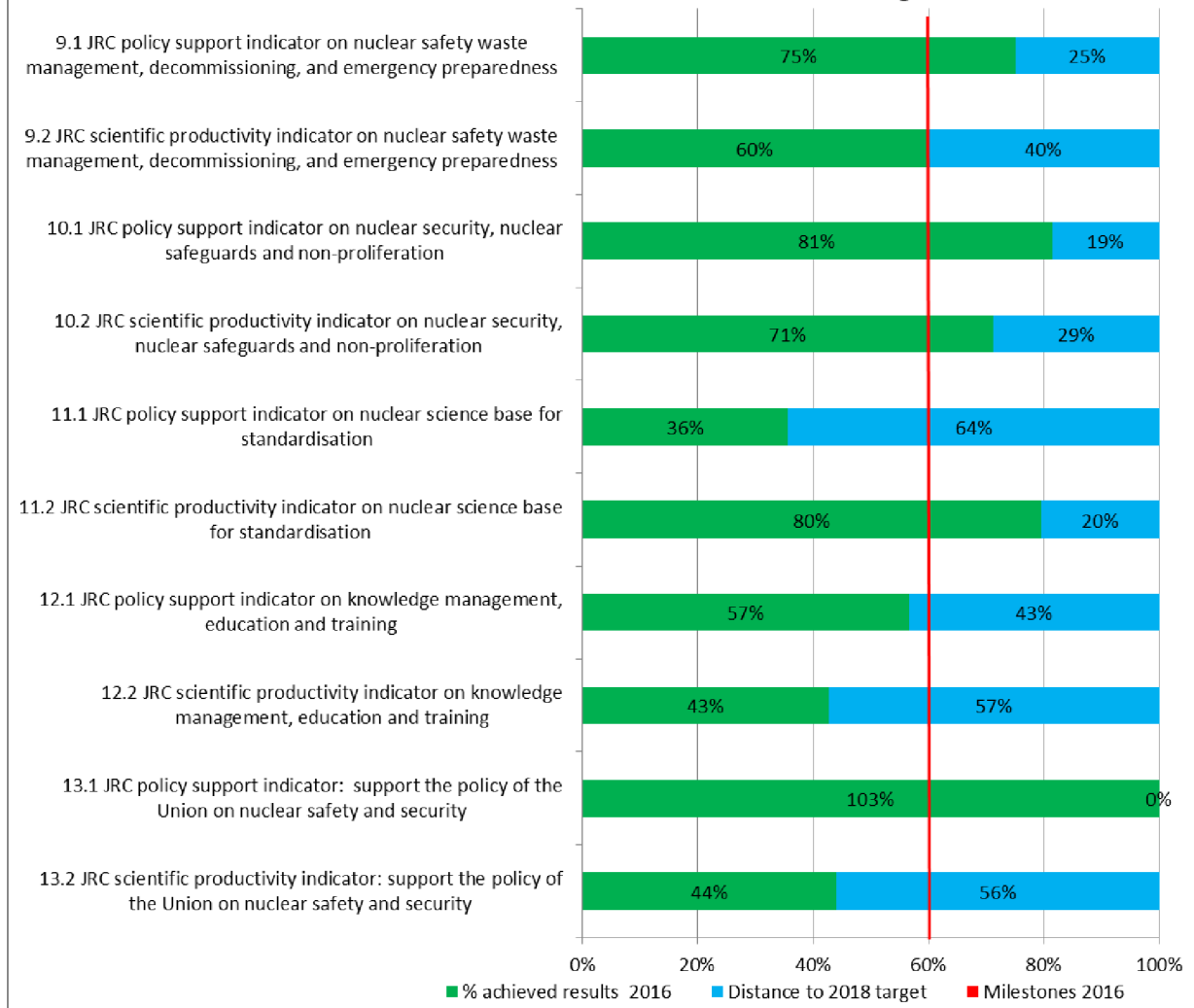
The programme as a whole is on track; 6 out of 10 indicators are performing above the milestone, and most of the others have small difference.

One indicator shows very high score in the fields of support to the EU policies, due to the high request of support the monitoring of the nuclear directives as some of them entered into force during the period, The support provided to the policy on standardisation in the nuclear field (KPI 11.1) needs more attention to achieve its objective.

Some additional effort to increase the scientific productivity in the fields of education and training is requested. The creation in 2016 of a new unit responsible of knowledge management should increase the results achieved in the area.

¹¹ Commission implementing decision of 28.2.2017 C(2017) 1288 final

Direct actions EURATOM - Distance to target



- **JRC policy support indicator:** number of occurrences of tangible specific impacts on Union policies resulting from technical and scientific policy support provided by the JRC
- **JRC scientific productivity indicator:** number of peer reviewed publications

5. RELEVANCE

5.1. Relevance of the topics addressed

To ensure that JRC's nuclear research and training activities are aligned with, and complement, the research and training needs of EU Member States, and to identify the critical areas where the JRC activities are relevant and have a European dimension, JRC participates in relevant fora together with Member State and international organizations and has established a strategy of concluding agreements with key stakeholders.

The interaction with the Euratom Scientific and Technical Committee (STC) was increased further. JRC hosts STC plenary meetings at its sites, offering opportunities for JRC scientists to interact with STC experts. In 2016, the JRC Director General has provided to the STC detailed insight about JRC activities, through a comprehensive questionnaire developed by the STC.

5.2. Relevance to European objectives

To ensure the relevance of the direct actions of the Euratom work programme to address the EU objectives providing an independent scientific basis for EU policies, the key orientations developed for its implementation are aligned with two policy areas of the President Juncker Commission's agenda:

3. A Resilient Energy Union with a Forward-Looking Climate Change Policy
9. Europe as a Stronger Global Actor.

The yearly JRC work programme is shared for consultation with the interested DGs during the preparation step, before being formally adopted by the Commission. JRC is also aware of the Community developments and priorities by attending regularly the Atomic Questions Working Party of the Council and being represented in the R&D groups of EU Member States (MS).

The activities carried out support the implementation of Council directives and conclusions on nuclear safety, waste management and radiation protection giving priority to the highest standards for nuclear safety in the Union and internationally. They also provide unique 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 EU Member State front line officers and experts at the JRC nuclear training facilities.

5.3. Relevance to stakeholders needs

To ensure the relevance of its nuclear safety programme for the stakeholders, the Commission, represented by JRC and RTD is a member of the Sustainable Nuclear Energy Technology Platform¹², SNE-TP, (governing board and executive committee) and its pillars: Nuclear GENERation II & III Association¹³ (NUGENIA) (honorary member and secretariat), European Sustainable Nuclear Industrial Initiative¹⁴ (ESNII) and Nuclear Cogeneration Industrial Initiative¹⁵ (NC2I). The JRC also contributes to the activities generated or supported by the European Nuclear Safety Regulatory Group (ENSREG) and participates in the meetings and working groups of

¹² <http://www.snetp.eu/>

¹³ <http://www.nugenia.org/>

¹⁴ <http://www.snetp.eu/esnii/>

¹⁵ <http://www.snetp.eu/nc2i/>

European Nuclear Energy Forum. JRC is an important provider of nuclear references materials and data.

The JRC is a partner and supports the European Nuclear Education Network association¹⁶. The direct actions also support 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 priorities in the JRC nuclear safeguards and non-proliferation programme are fully in line with the R&D challenges identified in the ESARDA¹⁷ (European Safeguards Research and Development Association) working groups, representing the EU Member States R&D groups, authorities and industry in this area.

To ensure that direct actions are aligned with and complement the research and training needs of Member States JRC is continuously interacting with the main research and scientific institutions. To improve the collaboration, and to build partnerships, agreements are concluded with main scientific and technical institutions in several EU MS: Belgium, Czech Republic, Germany, Finland, Spain, France, Hungary, The Netherlands and Spain.

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. This is achieved through several ongoing agreements with the main established nuclear international organisations, International Atomic Energy Agency¹⁸ (IAEA) and Nuclear Energy Agency (NEA) and important institutions from US, Japan, Canada, China, Israel.

The JRC cooperates with, and is member of, several Committees and working groups and participates in widely recognised international conferences or meetings on nuclear safety, nuclear security, nuclear safeguards, standardisation, knowledge management, and education and training.

The JRC is the implementing body of Euratom in the Generation IV International Forum and thus represents the Community in this forum. This important role allows the JRC to be continuously aware of the needs and developments related to advanced nuclear reactor systems. JRC contributes also technically to those developments with its work programme mainly on safety and security aspects.

¹⁶ Collaborative research agreement n. 34631 between the JRC of the European Commission and the European Nuclear Education Network

¹⁷ <https://esarda.jrc.ec.europa.eu/>

¹⁸ The European Commission Cooperative Support Programme: Activities and Achievements IAEA-CN-184/230

6. EFFECTIVENESS

The programme is achieving its overall objective by providing scientific and technological support for EU nuclear safety, safeguards and security research and training policies; at the same time, it is contributing to improve the nuclear security and nuclear safety in Europe and worldwide.

6.1. Outputs delivered

The JRC work programme is contributing to the improvement of the safety of nuclear reactors in partnership with local regulators and Technical Support Organisations, addressing challenges related and contributing to develop codes, standards and test methods for advanced reactor materials.

The activities on the safety of current nuclear fuels are intended to develop codes, standards and test methods for the safety analysis of light water reactor fuel behaviour and to provide reference data, software tools, and knowledge of the behaviour of nuclear fuel at high-temperature and during severe accidents for modelling and management. These activities also support the assessment of ageing of nuclear power plants for its long-term operation.

As Euratom's implementing agent of the Generation IV International Forum(GIF), the JRC is active here on underpinning and applied research on the safety of fuels for five Generation-IV systems, focusing on the four prototype reactors defined in the ESNII roadmap and being developed in the EU -ASTRID, ALFRED, MYRRHA, and ALLEGRO. The well-established programme on safety of advanced nuclear technologies keeps the EU's leading role in promoting globally the highest standards of nuclear safety.

The direct actions carried out in the area of radioactive waste management cover every aspect of research, policy support and training, addressing basic concerns and technical aspects of a sound nuclear waste management strategy. JRC investigates the spent fuel characteristics, the properties and behaviour of the spent fuel rods during storage and in view of the geological disposal. The experimental research carried out on spent fuels and highly radioactive waste form materials is relevant for improving the safety of the nuclear 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 harmonization 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 the radioactivity levels in the environment. To this extent, JRC develops and implements IT systems like the European Radiological Data Exchange Platform (EURDEP) as well as the European Community Urgent Radiological Information Exchange¹⁹ (ECURIE) system, allowing an effective exchange of information in the event of a nuclear emergency.

The Commission's activities in the area of nuclear safeguards support the EU's strategic objective to reduce the risk of nuclear proliferation. For this, JRC provides the necessary technical support, including development of new safeguards technologies, and related training courses for Euratom inspectors to ensure an effective implementation of EU safeguards systems. Similar support is

¹⁹ <https://rem.jrc.ec.europa.eu/RemWeb/Index.aspx>

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, analyses and reports, 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, including nuclear forensics. They cover three major areas: research and development, support to Member States and international organisations, and capacity building activities. 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.

In its highly specialised large-scale nuclear facilities, the JRC produces and supplies state-of-the-art nuclear data, reference materials and measurements, conformity assessment tools, and nuclear training and education in all its areas of activity.

The 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 through its quality-based, peer reviewed open access projects (e.g. EUFRAT²⁰). Open access schemes to JRC research facilities will be further strengthened and extended through its new programme on opening access to its research infrastructures.

6.2. Expected long term results and impacts

The activities in the areas of structural integrity and accident modelling aim to deliver ageing assessment in relation to long term operation, and generally applicable software tools for accident modelling and accident management.

The research performed in the safety of conventional nuclear fuels is generating immediate impacts by developing software tools which increase the knowledge about fuel performance during normal and incidental conditions. The activities indisputably benefit nuclear safety of nuclear fuels.

There are no expectations that the development of innovative nuclear fuels and fuel cycles will impact EU policies in the short term. Supporting the development of advanced nuclear technologies in collaboration with key international partners should have impacts on long term EU policies regarding the potential role of nuclear energy for a sustainable energy policy.

In the area of Radioactive Waste Management the direct actions address basic concerns and scientific/technical aspects of a sound nuclear waste management strategy in support of the implementation of geological disposal of spent fuel and high level radioactive waste. These issues need to be appropriately addressed in order to clear regulatory and licensing procedures and initiate the implementation phase.

²⁰ Hamsch F. EUFRAT, the Open Access programme for the nuclear facilities at JRC-Geel : EURATOM Work Programme 2014-2016 project 504 ET-TAA . Geel (Belgium): European Commission - Joint Research Centre; 2016. JRC103345

In the area of Environmental Monitoring & radiation protection, the JRC fulfils the Commission's legal obligations and support Member States' responsibilities in relation to the EU and the IAEA. The activities such as the harmonization of the radioactivity measurement of national laboratories and training for a coherent monitoring programme in Europe prove that the JRC and the Member States institutions monitor the radiation in the environment with extreme care, precision and sense of responsibility.

The JRC's nuclear safeguards activities are fully aligned with EU strategic objectives and policies within the EU and provide the basis for support to the effective and efficient implementation of safeguards in third countries. The contribution of the R&D, development of equipment, in-field support and training courses for the nuclear inspectors are essential to allow the implementation of the Euratom Safeguards by DG ENER. The deliverables and impacts from cooperation with the IAEA and with some other key partners such as the US and Japan make timely and valuable contributions to the operation of the international safeguards regime.

Continuously improving the assurance of nuclear non-proliferation is a major objective shared by all Member States and the EU Institutions. The activities generated many examples of impacts on EU policies such as the improvement and harmonisation on EU export control system, the formulation of dual-use export control guidelines or the scientific support during the nuclear negotiations with Iran. The support to the IAEA also impacts the efficiency of the global non-proliferation regime.

The JRC has made an essential contribution to nuclear security and CBRN hazards developments over the past decade and a continuing demand for capacity building and related research and development is anticipated in the coming years. The JRC capability in this area, and its ability to support nuclear security work through related scientific and technical capability, will continue to be in demand.

The JRC projects dedicated to R&D and education and training for nuclear decommissioning were implemented, reflecting a growing trend in the nuclear sector.

JRC has a long list of initiatives in the field of Knowledge management, education and training, and expects to play a central role in the organization and coordination of these activities. The JRC is the right place for such a central role, as it has the long standing recognised expertise, the infrastructure, the programmes and the data bases. The existing and further developing open access policy of the JRC is an invaluable asset to achieve it. The JRC's activities in this area are important for the whole EU community to maintain sufficient nuclear-technology knowledge and technological capacity in Europe.

6.3. Success stories

Examples of successful JRC activities during the evaluation period are:

- The accident analysis group provides accident analyses related information in the event of a nuclear accident crisis to reinforce the JRC capabilities in the areas of Accident Analysis and Severe Accident Assessment. The group coordinates its activities in the field, internally with related projects and externally in a strong technical and scientific collaboration with EU TSOs, and with international organizations such as the IAEA and the OECD/NEA.

- Laser-heating studies revealed the high-temperature solid/liquid transitions in corium sub-systems, of great importance to assess the behaviour of Pu during core melt down and evaluate any criticality risks during degradation (Journal of Nuclear Materials 467, 660, awarded the 2016 Springs Award of American Ceramic Society).
- Ceramic-metal (CERMET) fuels show exemplary behaviour without fuel pellet cracking following irradiation in the Phénix reactor. The fuel pellets were fabricated at JRC in the frame of the FUTURIX experiment, (collaboration between CEA, DOE and JRC), and the post-irradiation examination is performed at JRC.
- In the frame of the Global Threat Reduction Initiative (GTRI), JRC shipped no longer needed nuclear material from its sites to the USA. A dedicated facility was constructed at the JRC-Karlsruhe facilities, the material was treated and packaged within a very short time frame. Apart from unprecedented praise from the GTRI programme organisers; this unique opportunity has reduced future financial liability of the JRC.
- In 2015, EURDEP commemorated its 20 years of operation, in support to DG ENER, IAEA and the European countries authorities competent for emergency preparedness and response. It was highlighted by the EURDEP international workshop and the High level event "20 years of radiation monitoring data exchange in Europe" organised both by JRC and DG ENER.
- Under the EC Support Programme to IAEA, a training course on Complementary Access (under the safeguards Additional Protocol) is organised annually since 2012. The aim is to familiarise IAEA inspectors with complementary access (CA) procedures in a nuclear R&D environment. In 2015, JRC hosted a workshop in its facility in Karlsruhe where best practices on the subject were agreed. As a result, dedicated training courses are being delivered at the Hungarian Atomic Energy Authority, and Brookhaven National Laboratory (USA).
- In the frame of its R&D on novel verification systems, JRC developed a fully innovative laser-based, self-localisation system for use by nuclear safeguards in complex installations. In a world-wide competition, organised by Microsoft in 2015, the JRC system outperformed all competition. Since this competition, the JRC acts as referee for these systems and its performance continues to be unbeaten until now.
- JRC acted as a reference and knowledge centre for the EU institutions (European Commission and EEAS) on the nuclear-related technical aspects on the agreement between the E3/EU+3 and Iran to reach a Joint Comprehensive Plan of Action (JCPOA). JRC provided ad-hoc technical analyses on the issues under negotiations, based on independent, unbiased knowledge and understanding of the aspects under discussion and their implications from a nuclear non-proliferation point of view.
- Prior to the Nuclear Security Summit 2016, JRC and US Department of State jointly organized a "Counter Nuclear Smuggling Workshop" to underline the continued need for strengthened international cooperation. Law enforcement and nuclear measurement experts from more than 30 countries concluded that close inter-agency cooperation and international information sharing enable an optimized use of investigative and technical capabilities to effectively counter nuclear smuggling acts.

- As a result of an OECD-NEA initiative, aiming at world-wide standardisation of evaluated nuclear data for harmonized safety assessments in nuclear energy, the Collaborative International Evaluated Library Organisation project (CIELO) was started. JRC is in charge of two nuclides contributing with accurate measurements and expert advice.
- Together with the Japanese Atomic Energy Agency (JAEA) JRC successfully developed and demonstrated at its GELINA accelerator facility an innovative technique for elemental and isotopic characterisation of molten fuel. The successful demonstration of the technique in presence of experts from EURATOM, IAEA and the US was bestowed in 2016 with the Award for Distinguished Technology Development of the Atomic Energy Society of Japan.
- A novel treatment for metastatic prostate cancer using Targeted Alpha Therapy has been developed in collaboration with the University Hospital Heidelberg. The novel therapy has been tested for the first time in humans in 2014 and overall 79 patients have been treated with remarkable results. Treated patients had previously failed available standard therapies, and had a mean life expectancy of 2-3 months when included in the study. The vast majority of patients showed significant biochemical and imaging responses and extensive prolongation of survival. Several patients in initially clinically critical conditions showed enduring complete responses.
- An EU High Level Scenario-Based Exercise on Nuclear Security was held on November 2016 at the JRC's facilities in Karlsruhe (Germany). The exercise, as defined by JRC and DG HOME, focused on the unique characteristics of the European Union and its Member States in the preparedness to a nuclear security event. It gathered representatives from 26 MS national institutions dealing with various aspects of nuclear security to discuss and exchange on existing strengths, weaknesses, needs and capabilities related to nuclear security. The exercise identified several areas requesting further attention: training and exercises, border detection technologies, nuclear forensic competences, preparedness for nuclear or radiological incidents, challenges for security of radioactive sources.

7. EFFICIENCY

7.1. JRC resources

7.1.1. The budget

Most of the JRC's resources are allocated through the budget for JRC's "direct research" of the Framework Programmes for Research. The budget allocated to JRC for the Research and Training Programme of the European Atomic Energy Community²¹, for the period 2014-2018, is **559.562.000 €**.

In addition to the JRC Framework Programme research budget, the JRC receives around € 30 million per year as specific credits to finance a decommissioning programme to reduce and dispose of its historical nuclear liabilities. These liabilities result from activities carried out on JRC sites in the past and concern the decommissioning of plants that have been shut down and the management of the associated waste. This decommissioning budget is not part of the research programme, although the JRC staff involved is supported by the research budget. The JRC is further developing synergies and exchanges between research programmes and the operational decommissioning activities.

In the budgetary execution, the JRC splits its research budget in three categories, which require the approximate percentage of the total budget indicated:

Staff expenses	60 %
Means of execution	31 %
Specific credits	9 %

Means of execution, refers to expenses like for maintenance of buildings and equipment, electricity, insurances
Specific credits (operational expenses) are direct scientific procurements.

7.1.2. The staff

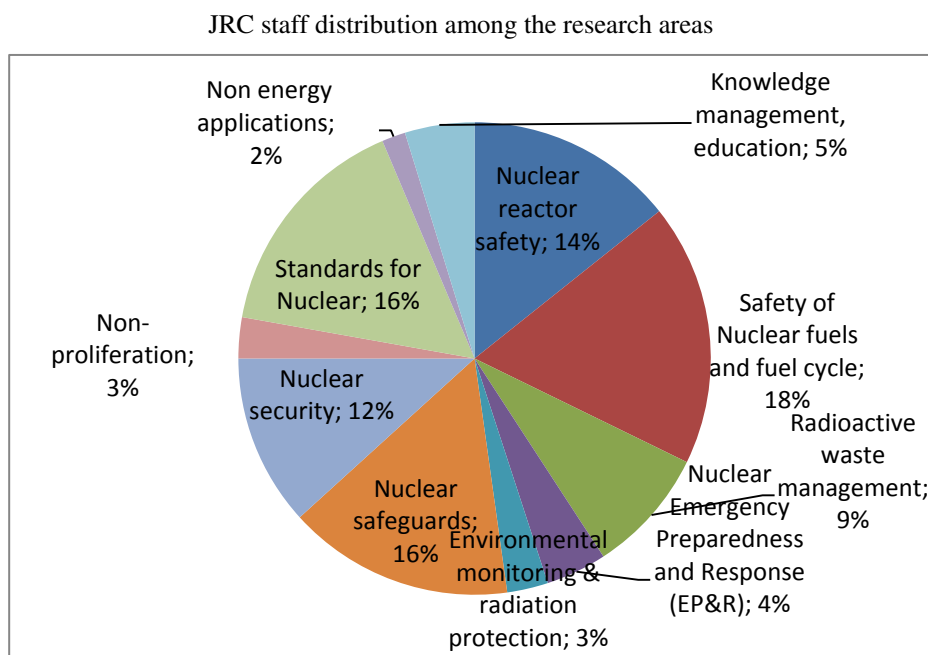
During the reporting period, the staff performing the Euratom direct actions consisted of about 710 members in 2014, being gradually reduced to 684 members in 2016. These staffs includes staff members performing direct research described in the programme, as well as staff assigned to infrastructure, maintenance and radioprotection, JRC decommissioning programme and staff in other supporting functions.

The categories of staff are distributed as showed in the table:

Scientist	33 %
Technicians	39 %
Support staff	12 %
Grantholders	15 %
Detached national experts	1 %

²¹ COUNCIL REGULATION (EURATOM) No 1314/2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018) complementing the Horizon 2020 Framework Programme for Research and Innovation, Article 4

The distribution of the staff among the research areas, during the period, is showed in the graphic:



7.2. JRC Euratom research and training programme, productivity and impact

The JRC carries annually on a corporate-wide yearly review, called JRC Productivity and Impact review (PRIME).

The exercise assesses the productivity as a first aspect, in terms of different categories of policy support outputs and scientific publications in ISI peer-review journals. The second aspect evaluated is the policy support impact of the outputs, analysed against a predefined generic set of impact indicators.

The outputs delivered are classified in two main groups:

7.2.1. Policy support outputs

These are outputs registered in JRC's Publication data base (Pubsy), intended for specific customer(s) and delivered in the indicated categories:

Policy support outputs	
Period 2014-2016	
Scientific for Policy reports	194
Technical reports	484
Validated methods, reference methods and measurements	8
Reference materials	12
Technical systems	68
Scientific information and databases	42
Training	117
Contributions to policy docs	20
Contribution to standards	8

7.2.2. Scientific outputs

JRC produced a number of scientific outputs registered in the JRC's publications data base:

JRC Scientific output Period 2014-2016	
Books	9
Articles and conference proceedings contributions published in peer-reviewed periodical	658
Articles contributing to monographs or other periodicals	157
PhD Theses	15

The JRC's research publications performance is well above average with a respectable productivity. A bibliometric analysis²² for the period 2007-2015 was carried out. It was focused on peer-reviewed articles in the field of Nuclear Science and Technology (NST) and based on widely accepted (publication and citation based) impact metrics. More than 15 % of the JRC publications are among the top 10 % most cited articles²³ in the NST field, which places the JRC around 50 % above the world average on this metric. Hence the JRC ranks well amongst peer organisation like CEA, Oak Ridge Laboratory and Argonne National Laboratory.

7.2.3. Impact achieved

The impact refers to tangible and documented instances of JRC's contribution to a scientific policy support for EU policies, via e.g. a European Commission DG, other EU institutions, a Member State authority, third country authorities or international organizations. The impact obtained through the support provided with the outputs delivered is classified in 5 categories:

JRC impact achieved Period 2014-2016	
Anticipation, conception, adoption of EU policy	11
Implementation, monitoring, evaluation of EU policy	126
Ad-hoc support (including crisis management)	10
EU and global standardisation and international harmonisation	43
Support to specific countries/regions and international bodies (other than standardisation or crisis support)	79
TOTAL	269

²² Bibliometric analysis of the research performance of the JRC under the Euratom Research and Training Programme (2007 - 2015)

²³ The percentage of publications in 'top 10% most cited articles' in a field is an indicator of 'excellence'; a measure of high quality of research output in this field.

8. COHERENCE

The Euratom programme for nuclear fission is one of the most relevant instruments to support the safety and security of nuclear energy in the EU and in the world. It distinguishes direct research, carried out by the European Commission in its Joint Research Centre (JRC) and indirect research, carried out by pan-European project consortia that include SMEs, large companies, universities and research centres (in some cases including JRC).

8.1. Internal coherence between areas of the programme

The Euratom work programme is defined to obtain five specific objectives, as described in the section 2.2. The last three of them, namely increasing excellence in the nuclear science base for standardisation, fostering knowledge management, education and training and supporting the policy of the Union on nuclear safety and security are cross-cutting the main objectives of improving nuclear safety and improving nuclear security. For its implementation, the work programme is divided in areas of activity, more specifically dealing with the different topics covered.

To ensure the right communication between the different areas of the programme, breaking the existing silos, a new governance model was adopted recently. According to the JRC strategy 2030²⁴, the new structure has been implemented. It puts all the responsibility on the implementation of the Euratom work programme under a single Directorate, as recommended by previous external evaluations²⁵ (ref to FP 7); this will provide evident improvements in transparency, effectiveness and efficiency, as well as coherence of the activities carried out.

The knowledge obtained and developed in areas of nuclear safety is reinforcing the research in nuclear security and vice versa. Insight gained in areas closer to basic science is being used in other scientific areas for more applicative purposes. At the same time, these three main domains (safety, security and underpinning science) are the basis for education and training or knowledge management activities, which make it available not only to the scientific community, but also to other stakeholders such as policy decision makers. All the activities take stock of the available expertise and further improve it to provide state of the art support to the EU policies in the field.

8.2. External coherence with main stakeholders

The JRC is making efforts to align its work, performed under the direct actions of the Euratom programme, with the research programmes carried out under other schemes such as indirect actions and MSs national programmes. It is also paying the appropriate attention to the policy needs of the Commission and other European services as EEAS or the Council.

At the same time, the direct actions under the current work programme are coherent in their evolution, which stems from previous framework programmes; being based on knowledge and expertise already accumulated, they constantly evolve to meet the evolving needs of the stakeholders.

To align its research programme with the stakeholders, JRC is a member of SNE-TP governing board and executive committee, and its pillars Nugenia, ESNII and NC2I.

²⁴ JRC strategy 2030 - https://ec.europa.eu/jrc/sites/jrcsh/files/jrc-strategy-2030_en.pdf

²⁵ Ex-post Evaluation of the direct actions of the Joint Research Centre under the Seventh Framework Programmes 2007-2013, July 2015, <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC96870/kjna27343enn.pdf>

The research activities in the JRC nuclear safeguards and non-proliferation programme are fully in line with challenges identified in the ESARDA.

JRC Euratom research and training programme through several agreements supports main nuclear international organisations, International Atomic Energy Agency (IAEA) and Nuclear Energy Agency (NEA) and important institutions from US, Japan, Canada, China, Israel

Additionally to the direct actions, financed by the Euratom Research & Training programme, the JRC generates external revenues through "contractual" work: i) participation in Indirect Actions of the Framework Programme as members of consortia and excellence networks, ii) contract work for third parties such as regional authorities or industry, and iii) additional support provided to Commission services,

The participation in these contractual activities complements the tasks outlined in the direct actions stemming from the work programme and is an important mechanism for gaining and sharing expertise and know-how. It also allows the JRC to be firmly integrated in the European research landscape.

9. EU ADDED VALUE

The EU added value of the direct actions of the Euratom research & training programme is displayed in several fronts:

The direct actions are complementing national research programmes, collaborating with national research organisations, universities or regulatory authorities. To ensure the relevance of the collaboration, JRC receives inputs from research platforms as Sustainable Nuclear Energy – Technological Platform and its pillars, and signs cooperation agreements with the main research Institutions in the field.

As part of the Commission, JRC is independent from national interests, therefore it is in the appropriate position to provide scientific and technical support to other Commission services in the preparation, implementation and monitoring of the EU policies. JRC supports the Commission in the implementation of the Instrument for Nuclear Safety Cooperation²⁶, Instrument contributing to Stability and Peace²⁷; the European safeguards regime²⁸, Nuclear Safety Directive, Nuclear Waste Directive, Basic Safety Standards Directive; the CBRNE action plan²⁹ or the dual use goods export control regime³⁰. This support can be provided due to the excellent and longstanding reputation the JRC has acquired and the knowledge it has developed through the Direct Actions of the research programme.

The Chapter 7 of the Euratom Treaty established the Commission obligation related to safeguards of nuclear materials. The direct actions of the research programme are developing the necessary knowledge to provide the scientific support for the fulfilment of this obligation. An intensive and long-lasting collaboration is carried out with EU MS through the operation of ESARDA (The European Safeguards Research and Development Association) to the direct benefit of DG ENER. A similar situation exists in relation to the implementation of articles 34 and 35, related to the measurement of radioactivity on the environment; the direct research carried out by the JRC intends to harmonise the measurements in the EU and abroad and to provide the appropriate tools to fulfil this obligation.

Another activity of evident EU added value is the Clearinghouse on Operational Experience Feedback (created in 2008), which facilitates the analysis and exchange of information on operational events in order to improve nuclear safety. Members are nuclear regulatory authorities from EU Member States operating nuclear power plants and Switzerland. The activities in support of standardization, open access of infrastructures unique in EU, or training activities as developed in fields such as safeguards, decommissioning or others have an evident added value and cannot be carried out in any other place.

Euratom is a signatory of Generation IV International Forum and the JRC is its implementing agent. In this capacity, JRC is coordinating Euratom's technical and scientific contribution to Generation IV, which can stem from JRC direct actions, DG RTD funded indirect actions and by EU Member States direct contribution.

²⁶ COUNCIL REGULATION (EURATOM) No 237/2014 establishing an Instrument for Nuclear Safety Cooperation

²⁷ REGULATION (EU) No 230/2014 establishing an instrument contributing to stability and peace

²⁸ COMMISSION REGULATION (Euratom) No 302/2005 on the application of Euratom safeguards

²⁹ COM(2009) 273 final COMMUNICATION on Strengthening Chemical, Biological, Radiological and Nuclear Security in the European Union – an EU CBRN Action Plan

³⁰ Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

10. KEY FINDINGS

10.1. Relevance

The JRC maintains a diverse programme of scientific and technical work in relation to nuclear safety, safeguards and security, which supports the EU policies and the Commission political agenda, providing an independent scientific basis for EU policies, and meets EU Member States' needs to complement their activities in the mentioned fields.

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 aligned 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)³¹.

The activities carried out support the implementation of Council directives and conclusions on nuclear safety, waste management and radiation protection giving priority to the highest standards for nuclear safety in the Union and internationally.

JRC is also providing unique 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 EU Member State front line officers and experts at the JRC nuclear training facilities.

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.

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. This is achieved through several ongoing agreements with the main established nuclear international organisations, International Atomic Energy Agency (IAEA) and Nuclear Energy Agency (NEA), and with key institutions from important non-EU countries (China, Japan, Russia, and the United States).

10.2. Effectiveness

The programme is achieving its overall objective by providing scientific and technological support for the EU nuclear safety and security research and training policies, at the same time, it is contributing to improve the nuclear security and nuclear safety in Europe and worldwide.

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.

³¹ <https://esarda.jrc.ec.europa.eu/>

The research on nuclear fuels provided tools and data for the safety analysis of fuel behaviour to better understand the 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 nuclear safety of advanced nuclear technologies is important for the EU to continue maintaining its leading role in promoting globally the highest standards in nuclear safety and security.

For radioactive waste management, every aspect of research, policy support and training is covered to address basic concerns and technical aspects of a sound nuclear waste management strategy. 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 harmonization 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 the radioactivity levels in the environment.

The Commission's activities in 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.

The JRC produced and supplied also state-of-the-art nuclear data, 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.

10.3. Efficiency

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 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 JRC 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 analysis³² 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.

10.4. Programme's internal coherence and EU added value

The internal coherence of the programme is ensured through the collaboration/alignment with national research organisations, complementing national research programmes and the participation and contribution to research managed by European technology platforms and organisations. The participation of JRC in indirect actions is an instrument to improve the interaction and synergies across the direct and indirect actions of the Euratom programme.

The EU added value of the direct actions of the Euratom research & training programme is demonstrated under several angles:

³² Bibliometric analysis of the research performance of the JRC under the Euratom research and training programme (2007 - 2015), JRC 103578.

- 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 Feedback³³, 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.

³³ <https://clearinghouse-oef.jrc.ec.europa.eu/>

11. LESSONS LEARNED – AREAS OF IMPROVEMENT

JRC has taken into consideration the recommendations provided by the ex-post evaluation of the direct actions of the Joint Research Centre under the EURATOM Seventh Framework Programmes 2007-2013, related to its management model.

In the new JRC structure, all nuclear activities are within Directorate G – Nuclear Safety and Security. A new vision and strategy embracing all JRC nuclear activities has been prepared. With this approach, the full JRC nuclear program is presented in a homogenous way and contributes to a JRC-wide more coherent approach in project/programme definition, execution, monitoring and evaluation.

To ensure the relevance and right orientation of its work programme, JRC has engaged itself to participate in the most significant platforms and networks, and is actively contributing to establish effective mechanisms of collaboration inside and also outside Europe. Within the EU Institutions, JRC cooperation with the interested DGs and the relevant Council committees has been and will be further enhanced. It is the intention of the JRC to maintain and strengthen these useful relationships with different stakeholders, to extend the network of contacts and to formalise existing collaborations.

The direct actions of the Euratom programme are achieving their objectives assigned as planned. The long term objectives to be reached are also clearly defined and the work is focused towards their achievement; it is credible that they will be obtained, considering the expertise, facilities and existing network of collaboration.

One identified area for improvement is related to the management of the knowledge obtained to improve the visibility and availability of the results obtained to the JRC stakeholders. The goal is to enable the transfer of knowledge and skills among partners in the EU and even worldwide. The JRC has the mandate and gives the appropriate priority to implement the necessary work; in fact, numerous initiatives are already in place and steps for improvement have been taken. Nevertheless, more can still be done, not only in relation with the direct actions but also considering the overall knowledge produced in Europe.

To satisfy this need, the JRC has established a unit for Knowledge Management attached to its Directorate for Nuclear Safety and Security. The mission of this unit is to manage and disseminate knowledge generated by the scientific units; to monitor knowledge available worldwide and to facilitate open access to JRC nuclear facilities including training and education. Attention is paid to anticipating knowledge needs, mapping knowledge gaps and suggesting research topics.

The new Collaborative Doctoral Partnerships initiative is an instrument to establish partnerships with higher education Institutions on specific PhD subjects. This will allow overcoming 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.

12. CONCLUSIONS

The external evaluation conducted by a panel of high-level independent experts between October 2016 and April 2017 confirmed the high relevance of the JRC direct actions of Euratom research and training programme for nuclear safety, security and safeguards research in Europe. JRC direct actions continue to be instrumental in promoting the research and training in nuclear field in Europe and tackling the related challenges. They constitute a diverse scientific and technical programme which supports the EU policies, the Commission political agenda and meets EU Member States needs in the field of nuclear safety and security and safeguards. The programme is achieving its objectives both by providing scientific and technological support for the EU research and training policies on nuclear safety and security, and also by contributing to improve the nuclear security and nuclear safety in Europe and worldwide.

Regarding efficiency and effectiveness of the Programme, the reports indicated some areas requiring some improvement. Some of the recommendations will be implemented during the next two years programme 2019-2020. Other recommendations, in particular those concerning the long-term aspects of nuclear research will be further analysed during the ex-ante impact assessment of the future Euratom programme planned under the new (post 2020) multiannual financial framework.

ANNEX 1: PROCEDURAL INFORMATION CONCERNING THE PROCESS TO PREPARE THE INTERIM EVALUATION OF INDIRECT ACTIONS OF THE EURATOM RESEARCH AND TRAINING PROGRAMME 2014-2018.

Lead DG: Joint Research Centre (JRC)

The requirement for the interim evaluation of Euratom programme derives from Article 22(1) of Regulation 1314/2013/Euratom establishing the programme. This stipulates that the Commission shall carry out, with the assistance of independent experts selected on the basis of a transparent process, an interim evaluation of the Euratom Programme on the achievements, at the level of results and progress towards impacts, of the objectives and continued relevance of all the measures, the efficiency and use of resources, the scope for further simplification, and European added value.

The interim evaluation of the Euratom programme started in 2016 and has been guided by an Inter-Service Group (ISG). A roadmap summarising the design, purpose and scope of the interim evaluation, was published in May 2016³⁴. An Inter-Service Group (ISG) gathering representatives of four Directorates-General (RTD, ENER, JRC, SG) of the Commission was set up in 2016.

To perform the interim evaluation of the direct actions, the JRC Director General, in consultation with the JRC Board of Governors selected a panel of six acknowledged experts. The JRC organised the evaluation and provided a secretariat as well as the necessary information as documents and reports compiling facts and figures and describing the scientific activities performed. Hearings at the four JRC sites with nuclear activities were organised to show the research infrastructure and to present the scientific activities and discuss with the experts.

The interim evaluation is based on a wide range of sources comprising internal monitoring and evaluation reports, produced yearly by Commission services as well as the external expert group report³⁵ and JRC reports prepared for its evaluation, the conclusions and recommendations of the ex-post evaluation of the Euratom 7th Framework Programme (FP7)³⁶ and the external report "Advice on JRC nuclear safety research activities" issued in September 2014.

³⁴ http://ec.europa.eu/smart-regulation/roadmaps/docs/2015_rtd_014_interim_evaluation_euratom_research_en.pdf

³⁵ Interim evaluation of the direct actions under the Euratom Research & Training Programme 2014-2018 DOI 10.2761/402387

³⁶ Ex-post evaluation of the direct actions of the JRC - EUR 27343 EN