



Brussels, 29 November 2024
(OR. en)

16405/24
ADD 1

RECH 532
ATO 80
COMPET 1177

COVER NOTE

From:	Secretary-General of the European Commission, signed by Ms Martine DEPREZ, Director
date of receipt:	28 November 2024
To:	Ms Thérèse BLANCHET, Secretary-General of the Council of the European Union

No. Cion doc.:	SWD(2024) 271 final - Part 1/2
Subject:	COMMISSION STAFF WORKING DOCUMENT EVALUATION Ex-post evaluation of direct actions under the Euratom Research and Training Programme 2014-2020 Accompanying the document REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE Ex-post evaluation of the Euratom Research and Training Programme 2014-2020

Delegations will find attached document SWD(2024) 271 final - Part 1/2.

Encl.: SWD(2024) 271 final - Part 1/2



EUROPEAN
COMMISSION

Brussels, 28.11.2024
SWD(2024) 271 final

PART 1/2

COMMISSION STAFF WORKING DOCUMENT

EVALUATION

**Ex-post evaluation of direct actions under the Euratom Research and Training
Programme 2014-2020**

Accompanying the document

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

Ex-post evaluation of the Euratom Research and Training Programme 2014-2020

{COM(2024) 549 final} - {SWD(2024) 272 final}

TABLE OF CONTENTS

Table of contents	1
Glossary	2
1. Introduction	4
1.1. Purpose and scope of the evaluation	4
2. What was the expected outcome of the intervention?	5
2.1. Description of the intervention and its objectives	5
2.2. Points of comparison	9
3. How has the situation evolved over the evaluation period?	10
3.1. Description of the current state of play	10
4. Evaluation findings (analytical part)	13
4.1. To what extent was the intervention successful and why?	13
4.1.1. Effectiveness	13
4.1.2. Efficiency	18
4.1.3. Coherence	22
4.2. How did the EU intervention make a difference?	23
4.3. Is the intervention still relevant?	25
5. What are the conclusions and lessons learned?	26
5.1. Conclusions	26
5.2. Lessons learned	28
Annex I. Procedural Information	30
Annex II. Methodology and Analytical models used	31
Annex III. Evaluation matrix and, where relevant, Details on answers to the evaluation questions (by criterion)	32
Annex IV. Overview of costs and benefits identified in the evaluation	37
Annex V. Stakeholders' consultation - Synopsis report	41

GLOSSARY

<i>Term or acronym</i>	<i>Meaning or definition</i>
ActUsLab	Actinide Use Laboratory (Laboratories in open access at JRC-Karlsruhe)
ANVS	Authority for Nuclear Safety and Radiation Protection (the Netherlands)
BfS	German Federal Office for Radiation Protection (Germany)
CBRN CoE	Chemical, Biological Radiological and Nuclear Centres of Excellence
CEA	Commissariat à l'énergie atomique et aux énergies alternatives
EEAS	European External Action Service
ECURIE	European Community urgent radiological information exchange
EERA	European Energy Research Alliance
ENEN	European Nuclear Education Network
ESARDA	European Safeguards Research and Development Association
EUFRAT	European research infrastructure for nuclear reaction, radioactivity, radiation and technology studies in science and applications (Laboratories in open Access at JRC-Geel)
EURDEP	European radiological data exchange platform
EURAD	European Joint programming on Radioactive Waste Management
EUSECTRA	European Nuclear Security Training Centre
JEFF	Joint Evaluated Fission and Fusion Nuclear Data library
FPI	Foreign Policy Instrument

GIF	Generation IV International Forum
JRC	Joint Research Centre
IAEA	International Atomic Energy Agency
IGD-TP	Implementing Geological Disposal of Radioactive Waste Technology Platform
INSC	Instrument for Nuclear Safety Cooperation
ITRAP	Illicit Trafficking Radiation Assessment Programme
MAWP	Multi-Annual Work Programme
NPP	Nuclear power plant
OECD-NEA	Organisation for Economic Cooperation and Development – Nuclear Energy Agency
PRIME	JRC Productivity and Impact Evaluation
SAMIRA	Strategic Agenda for Medical Ionising Radiation Applications
SNE-TP	Sustainable Nuclear Energy Technology Platform
US DoE	US Department of Energy

1. INTRODUCTION

1.1. Purpose and scope of the evaluation

This Staff Working Document presents the ex-post evaluation of the direct actions, described in the Euratom research and training programme for the period 2014-2020 and implemented by the Joint Research Centre (JRC) of the European Commission. It takes into account the ex-post evaluation of the previous Programme (2007-2013) ⁽¹⁾, as well as the interim evaluation of the Programme 2014-2018 ⁽²⁾. 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) ⁽³⁾ and the criteria stipulated for evaluations in the Better Regulation guidelines ⁽⁴⁾.

The Euratom Research and Training programme 2014-2018 ⁽⁵⁾ and its extension for the period 2019-2020 ⁽⁶⁾ (hereinafter the Euratom Programme) establish that the Commission will carry out an ex-post evaluation of the Programme, with the assistance of independent experts. It provides that the direct and indirect actions of the Programme will be evaluated separately. Additionally, conducting two separate evaluations for the direct and indirect actions is further justified by the fact that they were led by distinct specific sets of objectives in the Euratom regulation. Such evaluations will therefore assess the progress made towards the Programme objectives, as well as its long-term impact, to feed into the following decisions related to the renewal or modification of the Programme. It also evaluates the efficiency, use of resources and European added value and advices on the scope for further improvement. The recommendations drawn from this evaluation have already been in part taken up and implemented in the current Euratom programme 2021-2025 or echoed and followed up for the interim evaluation of the current programme.

Whilst fulfilling the obligation laid down in the Euratom Programme, this evaluation of the direct actions carried out by the JRC during the period 2014-2020 and in line with the better regulation principles, aims to:

- assess the continued relevance of the programme's objectives, including for European stakeholders;
- assess the efficiency and use of resources, the scope for simplification and the EU added value over action at Member State level;
- review the effectiveness, the 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;
- assist the JRC senior management with specific orientations for the current Euratom Research Programme;
- coherency of the programme both between its different parts and with other European and global research programmes, as well as with EU policies;
- build an evidence base for future impact assessments of nuclear activities of the JRC.

For this purpose, the evaluation was conducted with the support of an external panel of experts and based on the assessment provided, the European Commission drew its own evaluation analysis. The

⁽¹⁾ Ex-post Evaluation of the JRC's direct actions 2007-2013 (EUR 27343 EN)

⁽²⁾ Interim Evaluation of the JRC's direct actions 2014-2018 (EUR 28722 EN)

⁽³⁾ 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

⁽⁴⁾ Staff Working Document SWD 2021_305_en

⁽⁵⁾ Council Regulation 1314/2013 establishing the Euratom research and training programme 2014-2018

⁽⁶⁾ Council Regulation 2018/1563 establishing the Euratom research and training programme 2019-2020

external panel of experts carried out a review of the relevance 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 ⁽⁷⁾ contains conclusions and recommendations aiming to help the JRC improve the fulfilment of its role in the current period (2021-2027).

The selected experts Panel, assessed both research programmes Horizon 2020 and its accompanying Euratom Programme. It consisted of 15 high-level experts from different domains ⁽⁸⁾, including 4 experts in the nuclear field to adequately address the Euratom Programme, and get the point-of-view of other knowledge areas through the interaction between the panel members.

The Panel conducted desk research studying the legal bases, programme documents, performance reports such as the "JRC's scientific productivity and performance 2014-2020" and the annual JRC report "Productivity and impact reports", organisation charts and the organisation's public websites. The Panel reviewed also 12 case studies analysing the impact of selected JRC activities on science, society and policymaking. These studies included the feedback of the concerned policy DG and were evaluated by dedicated external panels.

In a second step, the Panel carried out fact-finding hearings to facilitate the assessment of the overall work and achievements obtained. Due to the restrictions imposed by the COVID-19 pandemic regarding travel and access to JRC sites, the hearings were held virtually, reducing the possibility to complement the formal discussions with informal meetings with JRC staff and with visits to their laboratories.

2. WHAT WAS THE EXPECTED OUTCOME OF THE INTERVENTION?

2.1. Description of the intervention and its objectives

The **main challenges** that the nuclear technology is confronted with, in order to further contribute to competitiveness, security of supply and decarbonisation of European energy systems, are to ensure continued high levels of safety, developing and implementing solutions for the management and disposal of ultimate waste, and maintaining nuclear skills. Equally important is the need to ensure a robust system of radiation protection, taking into consideration the benefits of the uses of radiation in medicine and in the industry. In view of the increasing concerns about proliferation risks and the threat of nuclear terrorism, it is also necessary to further develop appropriate safeguards in order to assure nuclear security in Europe and worldwide.

To face up to these challenges and to contribute to social prosperity, environmental sustainability and potentially to the decarbonisation of the energy-system, as well as to the security of the energy supply, a substantial research effort was developed.

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**, aiming to potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way.

The programme should strengthen the research framework in the nuclear field while avoiding duplication with Member States' research efforts. The programme should further enhance its role in education and training to maintain EU expertise in the field and to contribute to the European Research Area.

In order to achieve the general objective of the Programme, its direct actions carried out by JRC have the following specific objectives:

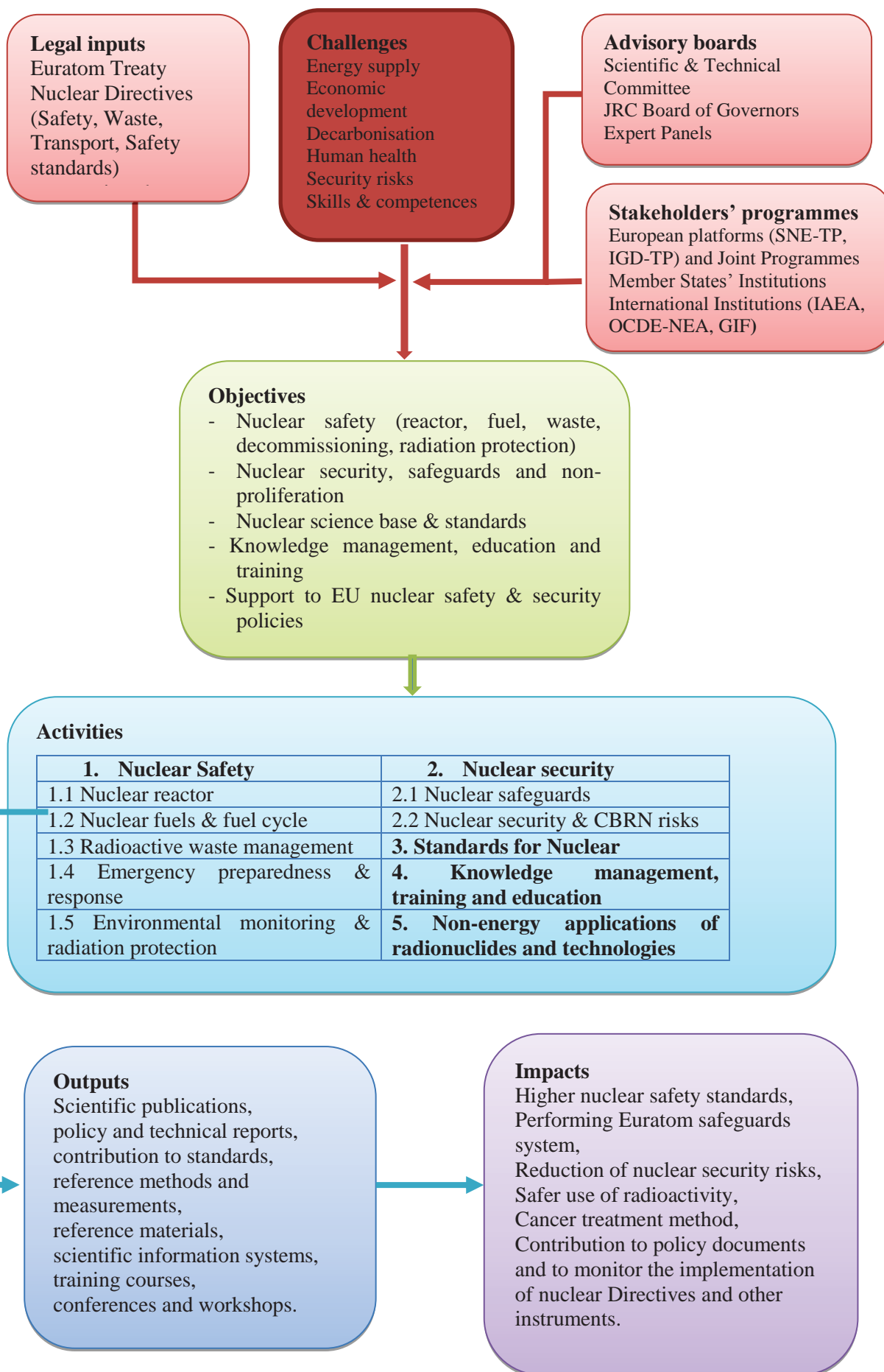
⁽⁷⁾ Heuer, R.D, et al., Ex post evaluation of the activities of the Joint Research Centre under Horizon 2020 and Euratom 2014-2020, Publications Office of the European Union, Luxembourg, 2022

⁽⁸⁾ Cf. Annex II for more information

- a. improving **nuclear safety (nuclear reactor, fuel, waste management, decommissioning and emergency preparedness)**:
 - by providing scientific support to EU policies in the area of nuclear reactor safety implementing innovative experimental testing, numerical simulation and modelling, feasibility and engineering studies, including harmonisation of codes and practices;
 - by testing and assessing nuclear fuel safety and understanding the key mechanisms and processes under various reactor conditions of relevance to the EU, under normal and transient conditions as well as under several accident scenarios;
 - by supporting Member States in updating the basic scientific knowledge of actinide materials and also to explore other nuclear applications such as medical therapy or long-lived energy supply in space;
 - by providing scientific support in the areas of spent fuel and high-level waste safety for storage and geological disposal, decommissioning and remediation of damaged reactors, conditioning and characterisation of special non-standard waste;
 - by developing and improving the emergency operational platform in support to nuclear emergency preparedness and response. Manage, operate and further develop the European Community emergency support information systems;
 - by supporting European Commission services in implementing the Instrument for Nuclear Safety Cooperation.
- b. improving **nuclear security**: including nuclear safeguards, non-proliferation, combating illicit trafficking, and nuclear forensics;
 - by enhancing safeguards efficiency and effectiveness with process monitoring tools, multi-sensor signals or sealing technologies and laser based containment;
 - by enhancing non-destructive analysis methods for nuclear materials analysis, detection, characterisation, quantification, free release;
 - by providing forensic analysis with timely and reliable results on real cases of seized radioactive materials and conducting R&D to improve methods to enhance abilities for nuclear forensics. Providing trainings and tools to forensics operatives;
 - by developing methodologies and tools for enhanced analysis and control of non-proliferation to the benefit of the IAEA, other European Commission services and in collaboration with EU Member States;
 - by supporting European Commission services in implementing CBRN instruments, the Instrument for Stability & Peace and the CBRN Action Plan.
- c. increasing excellence in the **nuclear science base** for standardisation;
 - by measuring new, improved and more complete nuclear data responding to stringent demands and contributing to international nuclear data libraries;
 - by contributing to harmonization of radioactivity measurements in Europe and worldwide both in routine measurement and monitoring conditions and in emergency preparedness situations;
 - by developing and providing certified reference materials and metrological quality assessment tools for method validation and quality control and developing high-quality nuclear targets;
- d. fostering **knowledge management, education and training**;
 - by providing practical trainings, summer schools and lectures, ensuring the open access to JRC nuclear infrastructures for researchers, managing knowledge databases and disseminating best practices;
- e. supporting the **policy of the Union** on nuclear safety and security.
 - by providing policy support to European Commission services on monitoring the implementation of the nuclear waste directive;
 - by providing methods and analysis of nuclear material for Euratom and the IAEA for the implementation of safeguards;

The JRC's activities aimed to provide a scientific basis for the relevant Union policies and to complement, within the limits of its mission and competence, the research carried out by the Member States. To that effect, the JRC carried out research and assessments, provided references and standards and delivered dedicated training and education. The activities carried out were developed in full alignment and complementary with the research programmes implemented by various EU Member States, seeking synergies, to optimise human and financial resources and to avoid duplication of nuclear research and development in the European Research Area.

By proposing solutions to existing challenges to improve nuclear safety, security, radiation protection and to develop non-energy applications of radioactivity, the Euratom Programme can indirectly contribute to social well-being, economic prosperity and environmental sustainability. Impacts of using this knowledge may cover some of the Sustainable Development Goals but only indirectly and over a long period of time.



2.2. Points of comparison

The impact assessment ⁽⁹⁾ conducted in 2011 identified specific issues that the Euratom research & training programmes 2014-2018 and 2019-2020 should address and on which its objectives were subsequently based:

Nuclear safety of current and future power plants:

- Research will need to address safety issues relevant for Europe arising from the detailed analyses of the Fukushima accident and the ‘stress tests’ carried out in the EU;
- Plans in most EU countries yielding nuclear power plants at the time were to extend their lifetimes on a case-by-case basis beyond 40 years, possibly beyond 50 years. Therefore, research also needs to focus on issues of importance such as long-term operation of the current nuclear fleet in Europe focussing on ageing mechanisms of structures, systems and components, including monitoring and prevention and mitigation measures;
- Research will need to improve the safety of existing plants by reducing uncertainties in areas such as fuel behaviour.

Next generation fission systems: in parallel to advances on “generation IV” systems, a broad-based program of R&D is needed in a number of key areas such as fundamental reactor designs, materials, numerical simulation and enhanced safety and non-proliferation as well as innovations on fuel and fuel cycle technology.

Management of nuclear waste: More than half of Member States have accumulations of spent nuclear fuel, or residues from the reprocessing of this fuel, as a result of the operation of nuclear power plants. The general principle is that the resulting waste should be managed in a safe and responsible way, without leaving undue burdens to the next generations. The R&D work carried out over last five decades has confirmed that deep geological disposal is the most appropriate solution for long-term management of spent fuel, high-level waste, and other long-lived radioactive wastes. As this scientific consensus needs to be turned into an engineering reality, the research will need to focus on long-term pre-disposal management of spent fuel, high-level waste, and other long-lived radioactive wastes and the implementation of geological disposal. In addition, it is also of importance to research techniques such as partitioning and transmutation to reduce the lifetime and radiotoxicity of the ultimate waste.

Education and training in the nuclear field: There are legitimate identified concerns in this area, faced with the prospect of retirement of a generation of nuclear physicists and engineers and a lack of proper turn over in the sector, combined with nuclear “phase out” policies in some Member States. This overall leaves a gap in the workforce, driving particular concerns when knowledge and expertise needs to be maintained, along with appropriate programmes of nuclear education and training, as essential prerequisites to ensure a high level of nuclear safety and nuclear safety culture for every sector in the nuclear field.

Nuclear safeguards and security: There is increasing concern about the risk of nuclear proliferation and the threat of nuclear terrorism. Safeguards of nuclear materials requires continued research and innovation efforts relying on knowledge and expertise at EU and worldwide level.

Radiation protection: in view of the rapidly growing use of radiation in medical diagnostic and therapeutic techniques, responsible for a significant rise in public exposure, further research is needed to determine the mechanisms involved and to quantify the risks at these low doses. Radiation protection in emergency situations such as under accidental conditions on and off-site equally require continued attention and improvement.

⁽⁹⁾ [SWD/2018/307 final](#)

3. HOW HAS THE SITUATION EVOLVED OVER THE EVALUATION PERIOD?

3.1. Description of the current state of play

To fulfil the objectives of the Euratom Research and Training Programme, complementing the research and training activities of EU Member States, and to identify the critical areas where the JRC activities are relevant and have a European dimension, JRC belongs to the appropriate fora and has established a strategy of concluding collaboration instruments with key stakeholders.

In this respect, JRC is member of or collaborates with the relevant EU associations and maintains agreements with research institutions from the EU Member States. Considering the global dimension of the nuclear research, it also holds agreements with institutions from third countries (US, Japan...) and cooperates with International Organisations, such as the IAEA and the OECD/NEA.

In order to develop the “high level” Programme and taking into account the priorities established in the Commission Work Programme, the JRC prepares its Multiannual work programme (MAWP) for a period of two years, and revises it annually.

The JRC's MAWP defines concrete objectives and deliverables, and attributes resources for each project planned. The draft MAWP is assessed internally, presented to the JRC Board of Governors for its opinion and submitted to an EC Interservice Consultation to get the opinion of other concerned Commission services, before being adopted by the Commission.

In addition to the direct actions of the work programme, the JRC carries out several contractual activities, complementing its own programme and providing a better integration in partnerships and networks. These activities are the participation in indirect actions of the Horizon 2020 Programme, the support provided to other Commission DGs in policy issues and contractual work for third parties.

Aiming to assess the performance of the programme and to analyse the strengths and weaknesses of the scientific activities, the JRC carries out a yearly review of the results obtained. The exercise assesses the productivity in terms of policy support outputs, scientific publications and other items delivered. The second aspect evaluated is the policy support impact of the outputs delivered, analysed against a predefined generic set of impact indicators.

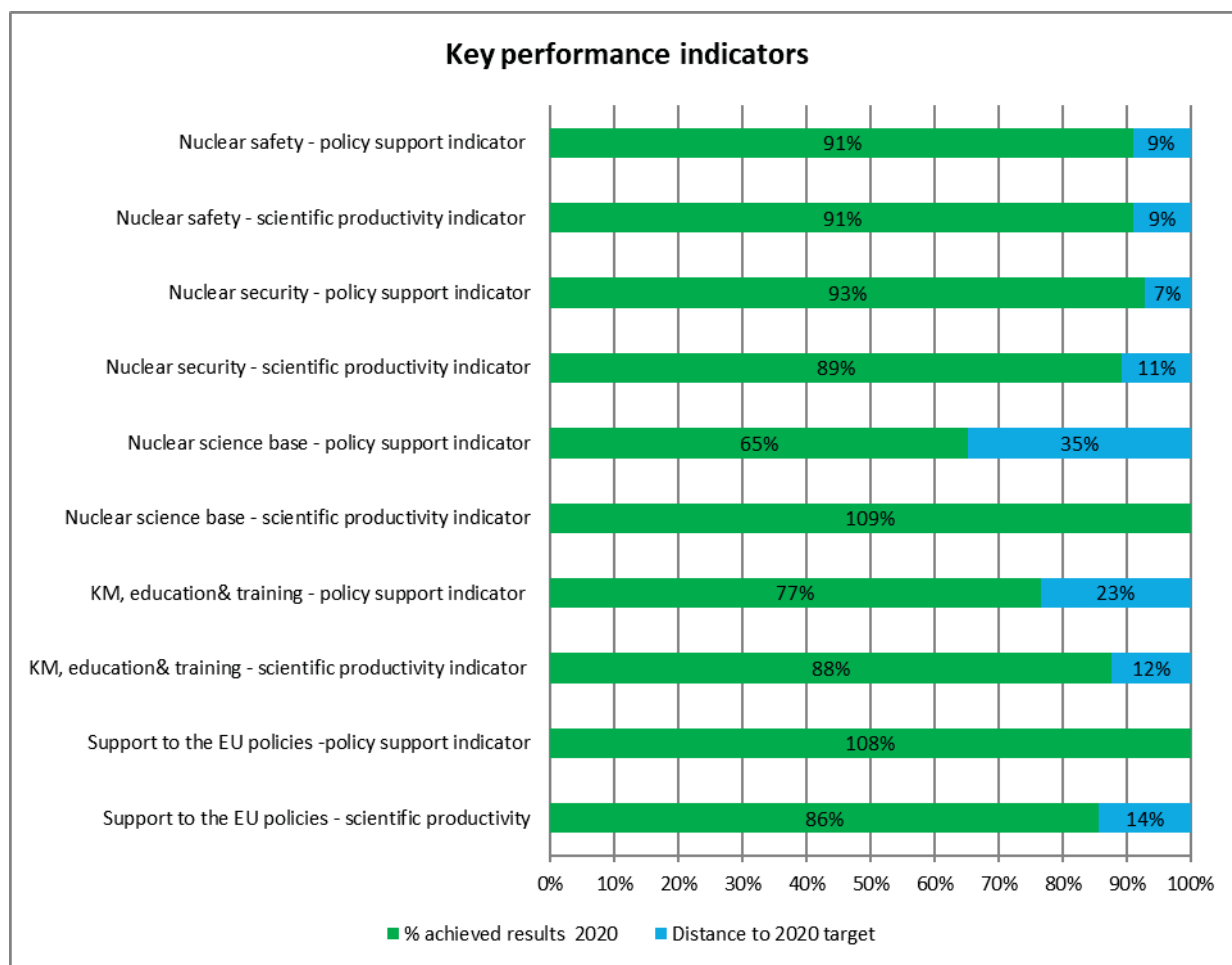
The Euratom Programme defines a series of performance indicators to assess the results and impacts for each one of the specific objectives defined:

- impact indicator for policy support: number of occurrences of tangible specific impacts on Union policies resulting from technical and scientific policy support provided by the JRC ⁽¹⁰⁾.
- scientific productivity indicator: number of scientific publications in peer reviewed journals

Over the period 2014-2020, JRC achieved:

- 92% of the target of 1170 peer-reviewed publications.
- 85% of the target of 440 tangible impacts on policymaking.

⁽¹⁰⁾ Proportion of JRC's direct research projects selected by the yearly internal PRIME exercise, which assesses the policy support impact of project outputs



For instance, the JRC research activities have impacted policy making by developing or modifying international standards, by providing technical systems which are now in use, by delivering reference materials to different partners, as well as reference data incorporated in nuclear libraries, by providing open access to its nuclear infrastructures, thus contributing to capacity building and upskilling or by training officials in EU Member States in nuclear forensics and nuclear inspectors in safeguards.

JRC experts supported the Commission in monitoring the progress of implementation of the Euratom Council Directives in nuclear safety, safe and responsible management of spent fuel and radioactive waste, basic safety standards, and on the supervision and control of shipments of radioactive waste and spent fuel by assessing the Member States National Reports and National Programmes, and contributing

to the preparation of the Commission Report to the Council and the European Parliament and their support documents ⁽¹¹⁾ ⁽¹²⁾ ⁽¹³⁾ ⁽¹⁴⁾ ⁽¹⁵⁾.

JRC provided expert support to the lifecycle of the EU projects funded by the Instrument for Nuclear Safety Cooperation, and for the Instrument contributing to Stability and Peace. In this latter one, JRC has also contributed to the implementation of some projects.

The COVID-19 pandemic had a significant impact on the research activities in 2020. The restrictions on the access to the laboratories obliged to prioritise the limited availability to:

- (1) Safety relevant tasks necessary to comply with the nuclear license requirements
- (2) Selected scientific projects with a contractual commitment
- (3) Other projects allowing more flexibility on delays

This situation resulted in significant delays for nearly all the laboratory activities, nevertheless, there are a couple of examples of successful adaptation to the situation:

- In the context of the pandemic, all the nuclear power plants have taken measures to mitigate the consequences. The JRC delivered immediately reports analysing the continued safe operation of the plants and the opportunities arising from the response adopted ⁽¹⁶⁾.
- The activities of the nuclear safeguards laboratories continued uninterrupted to ensure safeguarding of large flows of nuclear materials. Special attention was given to the hand-over of the Euratom safeguards laboratories at the reprocessing plant in Sellafield to the UK authorities after the UK's withdrawal from the EU.
- The open access to the JRC nuclear infrastructure was partially solved with remote monitoring of experiments.

⁽¹¹⁾ Report from the Commission to the Council and the European Parliament on progress of implementation of Council Directive 2011/70/Euratom and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects. COM/2017/0236 final

⁽¹²⁾ Commission Staff Working Document Progress of implementation of Council Directive 2011/70/EURATOM Accompanying the document Report from the Commission to the Council and the European Parliament on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects SWD/2017/0159 final

⁽¹³⁾ Commission Staff Working Document Inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects Accompanying the document REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on progress of implementation of Council Directive 2011/70/EURATOM and an inventory of radioactive waste and spent fuel present in the Community's territory and the future prospects SWD/2017/0161 final

⁽¹⁴⁾ REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL AND THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE on Member States implementation of the Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel Second Report. COM/2018/06 final

⁽¹⁵⁾ COMMISSION STAFF WORKING DOCUMENT Accompanying the document Report from the Commission to the Council, the European Parliament and the European Economic and Social Committee on the implementation by the Member States of Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel Second Report. SWD/2018/04 final

⁽¹⁶⁾ Martin, O. and Abbt, M., Current Challenges of the European Nuclear Supply Chain, EUR 30309 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-20872-3, doi:10.2760/23903, JRC121103

4. EVALUATION FINDINGS (ANALYTICAL PART)

4.1. To what extent was the intervention successful and why?

4.1.1. Effectiveness

Expert panel report conclusion

The Panel concludes in general positively on the effectiveness of the JRC, as judged by its impact on science and on policymaking. Stakeholders have noted that the effectiveness of interactions with the JRC and its policy relevance have further improved during 2014-2020.

Expert panel evaluation report

The **long-term operation of nuclear power plants** introduces new needs for ageing management and safety analyses as well as verified tools for these operations. This type of capacities exists at the JRC, especially the sharing of tools and data, developed through the Euratom programmes, serve the needs of the Member States.

As pointed out by the panel of experts in their conclusions, through the programme the JRC has effectively carried out scientific research and training activities in the nuclear safety, safeguards and security areas, providing technical support for EU related policies. With its unique expertise, JRC contributed to improve the nuclear security and nuclear safety in Europe and worldwide. Overall, the JRC was fairly successful in delivering outputs contributing to meeting the programmes objectives as exemplified below:

Outputs delivered

The JRC work programme contributed to the improvement of the safety of nuclear reactors addressing related challenges and contributing to developing codes, standards and test methods for advanced reactor materials, often in partnership with local regulators and Technical Support Organisations. These activities also support the assessment of ageing nuclear power plants for its long-term operation.

The research on current nuclear fuels improved further the safety analysis of light water reactor fuel, providing reference data, software tools, and knowledge of the behaviour of nuclear fuel at high-burnup and high temperature, during normal operation and during severe accident conditions for its modelling and management.

JRC carried out underpinning and applied research on the advanced nuclear systems and is the Euratom's implementing agent of the Generation IV International Forum (GIF) ⁽¹⁷⁾. The JRC participated in European research projects in the areas of sustainability, focused on waste management and resource utilization, on the safety and reliability and on proliferation resistance of Generation IV nuclear energy systems. It promotes the integration of the safety, security and safeguards aspects into the systems design.

The direct actions carried out in the area of radioactive waste management cover every aspects of research, policy support and training, addressing basic concerns and technical aspects of a sound nuclear waste management strategy. A specific yearly summer school on decommissioning and waste management, addressed to MSc and PhD students, provided a global overview of all relevant topics in this field, including on radiation protection. On the research side, the JRC investigated 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 provided technical support to implement the Directive on nuclear waste and spent fuel management, reviewing

⁽¹⁷⁾ GIF 2021 Annual report [GIF Portal - Portal Site Public Home \(gen-4.org\)](https://www.gen4.org/)

the national programmes and national reports on the implementation of the Directive (including EU waste inventory) and contributing to the development of an IAEA spent fuel and radioactive waste inventory reporting tool ⁽¹⁸⁾.

Aiming at harmonizing the radioactivity measurements performed by national laboratories, the JRC carried out several activities such as inter laboratory comparison exercises, which included the training of related personnel to ensure a coherent monitoring programme across Europe. The JRC develops and implements IT systems like the European Radiological Data Exchange Platform (EURDEP), as well as the European Community Urgent Radiological Information Exchange (ECURIE) system, allowing an effective exchange of information in the event of a nuclear emergency and supporting the fulfilment of the Euratom Treaty ⁽¹⁹⁾.

The Euratom Treaty, chapter 7 establishes the Commission's responsibilities in the area of safeguards to reduce the risk of nuclear proliferation. The JRC provided 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 has been 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.

Expert panel evaluation report:

The role of the JRC in supporting and developing **nuclear safeguards and non-proliferation** is essential for any current and future nuclear fuel cycle facility, in Europe and globally. For these goals, the JRC should ensure the availability of both human resources and the infrastructure for the experimental work and modelling activities.

JRC also conducted dedicated activities on nuclear non-proliferation, focusing mainly on concepts and methodologies in areas such as open-source information collection and analyses, strategic trade analysis and studies on export control of dual-use goods. These activities, developed to serve EU policies, also form the scientific base of the EC support programme to the IAEA and strengthen the global non-proliferation regime.

In the nuclear security field, the direct actions of the programme focused on detecting and responding to the illicit trafficking of nuclear and other radioactive materials, including nuclear forensics. They covered 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, has been in high demand by several Member States and international organisations.

In its highly specialised large-scale nuclear facilities, the JRC produced and supplied state-of-the-art nuclear data, reference materials and measurements, as well as conformity assessment tools. The JRC provided nuclear courses and hands-on vocational training for professionals and students in Member States and Commission departments. Moreover, the JRC allowed open access to its nuclear research infrastructures and offered complementary research possibilities to external users from EU Member States through its quality-based, peer reviewed open access programme. In collaboration with the indirect actions of the programme, which, since 2020, funds the user's cost, the open access schemes to JRC research facilities were further strengthened and extended, to include more facilities.

All these tangible and quantifiable outputs met specific indicator targets in the various areas of expertise of the JRC and served to illustrate both the scientific productivity and the concrete support to EU policy.

⁽¹⁸⁾ [SRIS - Spent Fuel and Radioactive Waste Information System \(iaea.org\)](https://sriss.iaea.org/) <https://sriss.iaea.org/>

⁽¹⁹⁾ Euratom Treaty, art 36, 37

Expected long term results and impacts

Based on current practice of research impact assessment, 12 case studies⁽²⁰⁾ describing activities in 2014-2020 were selected to be evaluated. These cases represent activities covering a broad spectrum in order to respond to the five specific objectives of the work programme. The cases selected were:

- **Clearinghouse on operating experience of nuclear power plants (2021):** through the Clearinghouse, the JRC runs the central offices of a regional network of nuclear safety authorities and their technical support organisations. This structure operated by the JRC plays an important role in enhancing nuclear safety by sharing best practices and supporting nuclear regulators in improving their regulatory frameworks. It has produced topical studies, maintains data on incidents and their analysis and help avoid similar events. The long-term impact is safer nuclear power plants for the benefit of society and the environment, by reducing the likelihood of accidental releases of radioactivity.
- **Spent nuclear fuel characterisation for safety assessments (2021):** In 2014-2020, the JRC has run an experimental campaign assessing the stability of irradiated fuel rods against external mechanical loading which might be accidentally applied. The experiments simulating accidental conditions were being conducted in the JRC's hot cell facilities, enabling tests on real spent fuel rods under different conditions. The experimental research was complemented with the development and distribution of the TRANSURANUS fuel performance code to 50 technical support organisations and research organisations in the EU and world-wide. JRC research on spent fuel rods' mechanical and chemical stability during extended interim storage provides a required scientific basis to license long-term storage of spent nuclear fuel. The long-term impacts involve reduced risks for public health and the environment.
- **The operation of the on-site laboratories and safeguards verification analysis (2021):** As part of the legal obligation based on article 7 of the Euratom Treaty related to the implementation of safeguards in the EU, the JRC operates on behalf of the European Commission on-site laboratories in Sellafield and La Hague to ensure efficient and effective safeguards at nuclear fuel reprocessing plants. At other installations handling large amounts of nuclear materials, the inventory is verified by nuclear inspectors accompanied by JRC staff. JRC scientists have notably developed analytical methods, procedures and quality control measures to deliver high quality results. In addition, they also provide trainings for nuclear inspectors. All in all, the JRC contribution in this area is impactful in enabling to achieve the objectives of its mandate.
- **JRC participation in the European Safeguards Research and Development Association (ESARDA) (2021):** The JRC permanently runs the secretariat of ESARDA and also held the presidency in 2019-2020. In the EU, ESARDA provides a forum for the exchange of information and ideas between nuclear facility operators, safeguards authorities and persons engaged in research and development. JRC's activities contribute to help Member States and the EU to implement both European and international nuclear safeguards regulations.
- **JRC Illicit Trafficking Radiation Assessment Program (ITRAP+10) Project (2021):** Under the ITRAP+10, a program initiated by the EU, the US and the IAEA to evaluate the performance of radiation detection equipment against consensus standards, JRC provided assessment of different technologies, developed procedures and standards and helped EU Member States laboratories build capacity. Overall, JRC contribution in this area achieved greater harmonisation and standardisation.
- **The European Nuclear Security Training Centre (EUSECTRA) (2021):** The JRC's European Nuclear Security Training Centre (EUSECTRA) builds competences in nuclear security, providing trainings to the front-line officers, law enforcement experts and nuclear measurement experts, organises case scenario-based exercises and enhances the international collaboration

⁽²⁰⁾ The case studies are used for internal review and assessment, and are not publicly available

building competences worldwide. It has established collaborations with the responsible Commission DGs, EU Member States and international partners (US, the IAEA), and has hosted trainees from over 80 different countries. This particular JRC contribution has a clear impact on the implementation of the EU security policy within and outside of the EU.

- **Confidence in nuclear systems – nuclear data (2021):** The JRC is an internationally recognised major contributor of experimental neutron data, and it is also strongly engaged in the evaluation community, contributing directly to the creation of new evaluations. The JRC operates unique, complementary and special experimental facilities to ensure that up-to-date nuclear data is available to the Member States and plays an important role in international reference data library initiatives such as the Joint Evaluated Nuclear Data Library for Fission Energy and Fusion Applications (JEFF), or organised by OECD-NEA and similarly contributes to the US, Japanese and IAEA nuclear data libraries. The JRC activities therefore continuously aims to improve nuclear safety, security and safeguards.
- **Open access to JRC nuclear research infrastructure (2021):** The JRC provides access to its nuclear research infrastructures in the frame of collaborative EU research projects and agreements and two dedicated JRC programmes EUFRAT (European facility for nuclear reaction and decay data measurements) and ActUsLab (Actinide User Laboratory). In 2014-2020, 158 projects have been accepted for execution in the JRC facilities. This open access programme contributes to the EU policy objectives of enabling scientists from the EU to perform experiments they could not otherwise carry out at national level. Moreover, the JRC also develops the competences and skills of young scientists and professionals.
- **Targeted alpha therapy – moving novel cancer treatments from bench to bedside (2021):** The JRC is using its expertise to contribute to all stages of the development of drugs from bench to bedside, including the development of chemical molecules needed for stable binding of alpha emitters to carrier molecules, preclinical research in vitro and in vivo and ultimately the clinical testing of promising novel compounds in patients that are conducted within a large network of clinical partners in the EU Member States and worldwide. Jointly developed standardised protocols and guidelines together with capacity building in hospitals and clinical research institutes, facilitate the use of novel approaches and radionuclide therapy in general. This research builds on the JRC's expertise and special infrastructure required to handle radioactive substances.
- **Addressing chemical, biological, radiological and nuclear threats outside the EU (CBRNE CoE) (2021):** The overall scope of the CBRN Centre of Excellence Initiative is to strengthen the long-term national and regional capabilities of responsible authorities and administrative infrastructures, and develop a durable cooperation legacy in the fight against the CBRN threat. It is led, financed and implemented by the European Commission International Partnerships ⁽²¹⁾ and the JRC, in close cooperation with EEAS. The JRC supports the network of 62 partner countries, their officially nominated national focal points and CBRN national teams in assessing their needs and drafting subsequent integrated national CBRN action plans. This enhances regulation, governance and helps building capacity to prevent and mitigate CBRN risks in partner countries.
- **Strategic Trade Control (2021):** The harmonised implementation of the EU Dual-use Regulation and its amendments by EU Member States is monitored by DG Trade with the support of the JRC since 2010. The JRC contribution includes the annual amendments of the EU dual-use control list, the collection and analysis of license data and of denied export authorisations, technical reach-back to authorities and Commission services, capacity building for authorities, the assessment of related sanctions measures and of topical issues. During the period under evaluation issues such as the impact of the UK's withdrawal on the EU dual-use trade were assessed. The EU dual-use regulation has also been recently amended with the recast

⁽²¹⁾ Since 2021, the management is under the Service for Foreign Policy Instruments (FPI)

(EU) 2021/821, with the support of the JRC. This overall contributes to harmonising implementation, creating a level-playing field and reducing risks of proliferation.

- Supporting the implementation of the Instrument for Nuclear Safety Cooperation (INSC) (2021): The JRC has supported DG International Partnerships in implementing the Instrument for Nuclear Safety Cooperation (INSC) from its inception in 2007. In 2014-2020, the JRC's independent and neutral technical experts were involved in all phases of the project management cycle and have contributed to ensuring efficient and effective implementation of the €225 million funding programme. Implementing the projects enhances the regulatory frameworks and capacity in third countries, reduces the risk of nuclear accidents and helps addressing nuclear waste management and decommissioning together with remediation of historical polluted sites.

The case studies were drafted on the basis of the information and data collected internally at JRC and validated by collecting feedback from partner DGs and other stakeholders. The impact was evaluated by independent external experts against a set of criteria, along four dimensions:

- Use in policymaking, assessing the contribution of the JRC's research to shaping, implementing and evaluating EU policies.
- Impact on public debate, contributing to inform the public opinion on specific subjects and solutions.
- Impact on scientific debate, which covers the bibliometric analysis of its own research articles, as well as the use of any JRC's output by the scientific community, conferences participation and academic recognition.
- Long-term societal impact, intending to measure the JRC's expected long-term impacts.

The experts found that the JRC's contribution was instrumental in **shaping and implementing EU policies** in all the cases, and it influenced other stakeholders and interest groups at EU and international levels in 92% of the cases.

The **long-term societal impacts**, achieved by the case studies evaluated, addressed in particular environmental, social or health issues, which could be clearly linked or traced to the JRC actions in 92% of the cases. Such impacts are especially visible in the case of (i) JRC's research on targeted alpha therapy and its direct contribution to cancer treatments; (ii) JRC's technical experience to address the remediation of contaminated Uranium mining legacy sites in Central Asia in the framework of the INSC or (iii) the contribution to the safety assessment of nuclear spent fuel management, which supports the reduction of risks for public health or the environment. These impacts reach a diverse range of stakeholders even beyond the EU.

Because of the sensitive, confidential or highly technical nature of the nuclear research activities, their contribution to the public debate remains more limited than for the non-nuclear activities of the JRC, reaching limited audiences and sectoral stakeholders in 66% of the cases.

The experts also assessed the JRC's contributions to the **scientific knowledge** and concluded for 42% of the cases that, besides the policy-support services, the JRC produced well cited peer-reviewed work, often published in top-10 journals, mainly in its specific knowledge area. This complements and supports the results achieved by the JRC in terms of scientific productivity, as illustrated by the KPI's targets above.

Overall, the experts' assessments together with the feedback collected from the partner DGs support the JRC's standing as a competent and effective science and knowledge service. Overall, these case studies are concrete illustrations of the direct actions policy impact and their effective contribution to meeting the objectives set in the Euratom programme.

Besides the cases studied, the impact of some general activities should be considered:

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, abnormal and accidental conditions. Both sets of activities indisputably benefit the 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 medium and 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 of the programme contribute to address basic concerns and scientific/technical aspects of a sound nuclear waste management strategy in support of clear regulatory and licensing procedures for the geological disposal of spent fuel and high level radioactive waste.

In the area of environmental monitoring and radiation protection, by maintaining the information and alert systems (EURDEP and ECURIE), the JRC helps the Commission's to uphold the Euratom Treaty and support Member States' in observing their obligations to provide information on the environmental radioactivity levels.

The contribution of the JRC's nuclear safeguards activities, including R&D, equipment development, in-field support and training courses for the nuclear inspectors, was essential to allow the implementation of the Euratom Safeguards regime. The support provided to the IAEA and the cooperation with other key partners, such as the US and Japan, make timely and valuable contributions to the operation of the international safeguards regime.

JRC carried out many initiatives in the field of knowledge management, education and training, and expects to continue playing 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 a long-standing recognised expertise, the infrastructures, the programmes and the data bases.

4.1.2. Efficiency

Expert panel evaluation report

The Panel acknowledges that several initiatives taken in the reference period, such as the introduction of a common project management methodology across the JRC, and the bundling of all nuclear science activities in one directorate, can enhance efficiency

A. JRC resources

The budget

Most of the JRC's resources are allocated through the budget for JRC's "direct research" of the Research Framework Programmes. The budget allocated for the direct actions of the Programme of the European Atomic Energy Community, for the period 2014-2020, was 828.369.000 €.

In addition to the JRC Framework Programme research budget, the JRC received 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 nuclear research installations that have been shut down and the

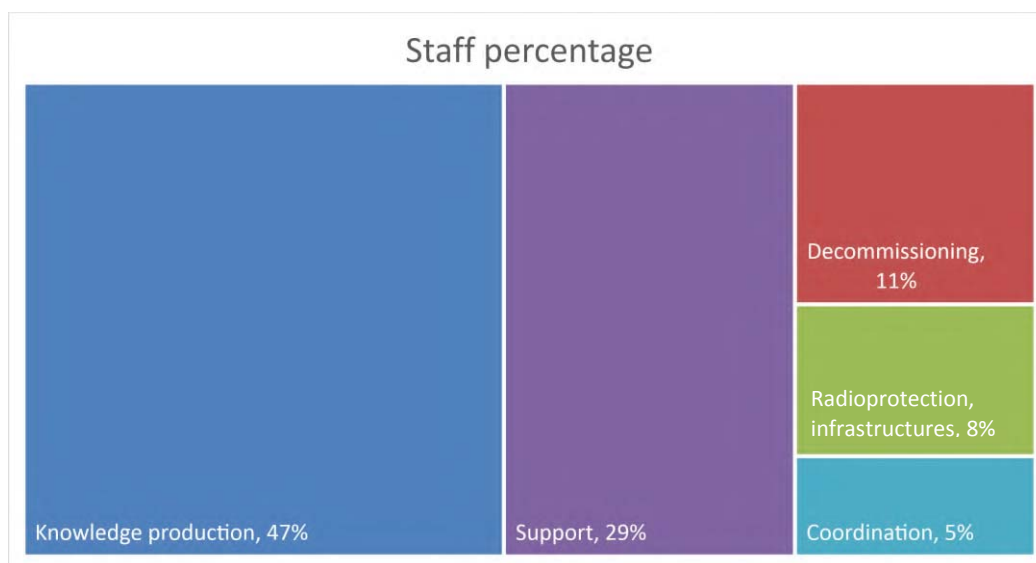
management of the associated waste. This decommissioning budget is not part of the research programme, although the JRC staff involved is supported by the research budget. The JRC is further developing synergies and exchanges between research programmes and the operational decommissioning activities.

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

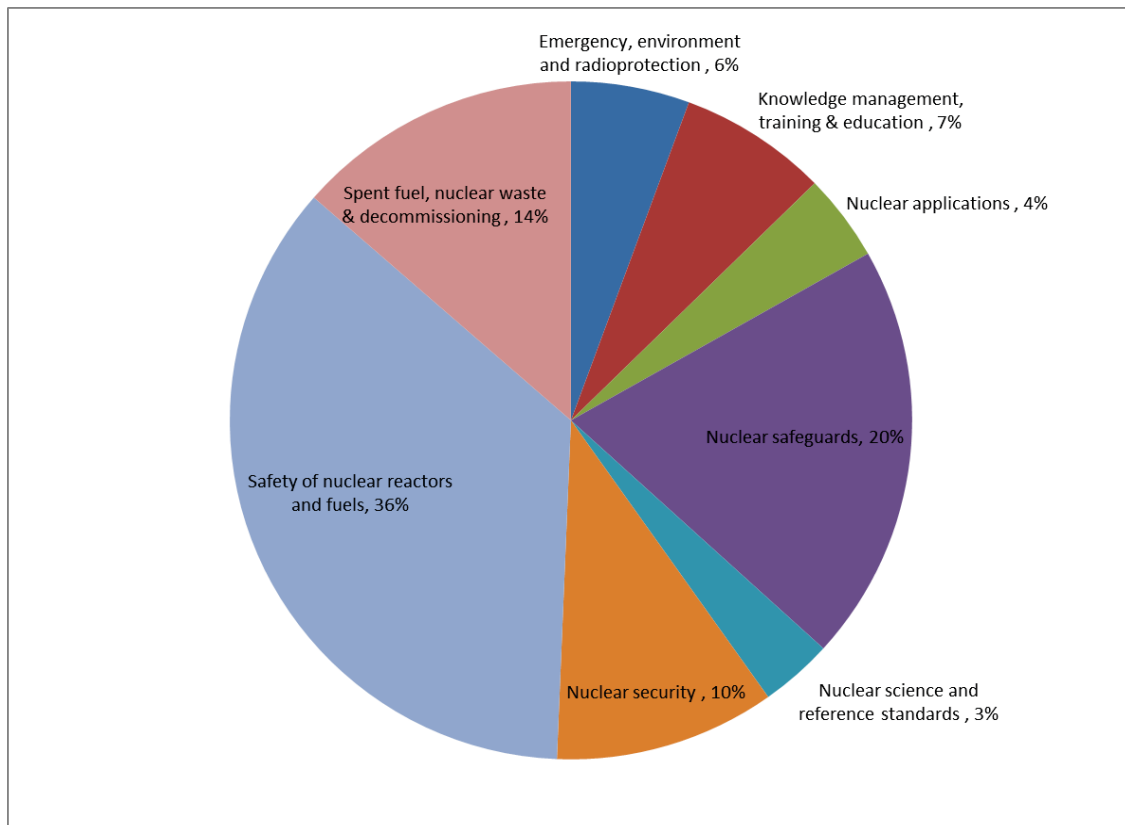
JRC Euratom budget distribution	
Staff expenses	55 %
Means of execution (maintenance of buildings and equipment, electricity, insurances...)	36 %
Specific credits (operational expenses)	9 %

The staff

During the reporting period, the staff performing the Euratom direct actions consisted of about 710 members in 2014, being gradually reduced to about 660 members at the end of the period considered. These staffs include 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.



Although the distribution of the staff among the research areas was evolving during the period, an approximate representation is showed in the graphic:



Efficiency measures were put in place during the evaluated period by means of resource re-allocation accomplished by reattributing positions of staff leaving, phasing out of some activities based on political priority or operational maturity. The external panel of experts has considered that *“the areas strengthened were broadly in line with political priorities and the ambition of the JRC to become more central to policymaking.”*

The panel however noted that the JRC did not have clear indicators for measuring the efficiency of its science for policy support.

Additional initiatives have also been implemented during the reference period to improve efficiency by introducing a common project management methodology across the JRC and bundling all nuclear research activities under a single directorate.

B. Productivity and impact

The JRC carries out a corporate-wide yearly review, called JRC Productivity and Impact review (PRIME). The exercise assesses the productivity, 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 two dimensions analysed are:

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:

Science-for-policy reports	50
Contribution to policy documents	49
Technical Reports	1064

Contributions to standards	31
Reference Material	36
Validated methods, reference methods and measurements	20
Technical systems	147
Scientific information systems, databases, datasets	90
Training	154
Project management documents/reports	47

Scientific outputs

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

Articles and conference proceedings contributions published in peer-reviewed periodical	1076
Articles contributing to monographs or published in other periodicals	444
Books and chapters of books	51
PhD Theses	28

The JRC's research publications performance is very satisfactory with a respectable productivity. Looking at the main bibliometric indicators and impact metrics, the JRC publications have been cited well above the world averages, ranking very well among the index (top 1% and top 10 %) most cited publications and being published in the most-cited journals. Hence the JRC ranks well amongst peer organisations like CEA (FR), Oak Ridge Laboratory and Argonne National Laboratory (US).

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 outputs delivered to provide support to EU policies obtained **373 tangible impacts** in the period analysed.

Expert panel evaluation report

The JRC should develop key performance indicators for measuring the efficiency of its science for policy support.

The interim evaluation report of the Euratom programme 2014-2018 recommended that JRC takes on the burden of proof of its cost-effectiveness. To answer to this recommendation JRC carried out a study to assess the cost-effectiveness of the JRC, by comparing the costs with the costs of other research institutions in research programmes with a comparable impact. The study specifically compared the resources and outputs from the JRC participation in three indirect actions of the Euratom programme to that of consortium partners. The indirect actions projects were selected based on (i) the relevance of the JRC role; (ii) the fact it provided an effort comparable in terms of human resources to that of other institutions and (ii) that the participation reflected the use of JRC's nuclear infrastructures. The comparison requires an expert judgement, as the tasks carried out by the different partners are quite unique and all of them necessary for the success of the three actions. This method however faces limitations as it is subject to different interpretations.

The analysis of the tasks performed and comparison of the means used for the main institutions cooperating in the big EU projects selected showed that:

- JRC is doing mainly experimental scientific work in these projects, using expensive equipment and installations and its participation is essential to the project.

- The cost of the JRC participation is in line with the cost of other partners, therefore the cost-effectiveness of the JRC is in line with the other partners of these projects, which are main research national Institutions of the EU.

For the Euratom programme 2021-2025, a complete set of key performance indicators has been proposed. These indicators are designed to measure the impact pathway at short, medium and long term in relation to the scientific, societal, innovation and policy impact aspects. These indicators will provide a complete and wide vision of the total impact achieved by the programme.

4.1.3. Coherence

Internal coherence between areas of the programme

The Euratom work programme describes five specific objectives for its direct actions, already described in the section 2.1. 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, dealing with the different topics covered.

To ensure the right communication between the different areas of the programme, breaking the existing silos and fostering the cooperation between the different areas, a new governance model was adopted in 2016. The new structure implemented puts all the responsibility of the implementation of the Euratom work programme under a single Directorate, as recommended by previous external evaluations ⁽²²⁾; this brought improvements on transparency of the work programme and on effectiveness, efficiency and coherence of the activities carried out.

The research areas are coherent with each other; the knowledge obtained and developed in areas of nuclear safety and waste management is reinforcing the research in nuclear safeguards and 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 scientific basis that allows providing education and training or managing the knowledge 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. Examples of comprehensive works, gathering several areas of the programme, are the JRC Technical assessment on support of the Taxonomy Regulation, released on 2021, or, the participation in technical groups of the Generation IV International Forum as Euratom implementing agent, aiming to consider all the research aspects already in the design phases of future nuclear reactors.

The experts' panel, that performed the interim evaluation of the programme 2014-2018, recommended *to bring a "rapprochement" between the indirect and direct actions of the fission research programme*. To ensure the coherence between both parts of the programme, the JRC participates in 40 indirect actions, out of 97 granted, as member of consortia. 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.

To implement the recommendation received and to obtain synergies between the two complementary parts, the programme 2021-2025 has a list of common objectives and indicators for both the direct and indirect actions. JRC decided to participate in the indirect actions of the programme 2021-2025, covering the participation with its own budget and not requesting additional funding from the indirect actions. To

⁽²²⁾ EUR 27343 EN, Ex-post evaluation of the JRC's direct actions under the seventh FP (2007-2013)

prepare this model of participation, examining the possible administrative issues, three pilot projects were agreed for the call 2019-2020, where JRC budget covers its own cost of participation.

External coherence with main stakeholders

Expert panel evaluation report

The JRC's open access policy promotes the coherence between direct and indirect actions, but also with national programmes.

To ensure the external coherence of the programme, the JRC aligned its work, with the research programmes carried out under other schemes such as international and Member States National programmes. In order to tighten the contact with its EU stakeholders, JRC is a member or observer of technological platforms like SNE-TP (Sustainable nuclear energy TP) and IGD-TP (Implementing Geological Disposal of radioactive waste TP) and it cooperates with the EERA-Joint programme on Nuclear Materials and with the ENEN association (European nuclear education network).

The research activities in the JRC nuclear safeguards and non-proliferation programme were fully in line with challenges identified in the ESARDA (European Safeguards Research and Development Association), where JRC is a party and holds the secretariat.

The JRC has bilateral cooperation agreements, in several research fields of the Euratom programme, with the main EU research Institutions and with Institutions from countries such as Switzerland, US or Japan. The programme, through several agreements, supports main nuclear international organisations such as IAEA and OECD-NEA. Therefore the research carried out was coherent at EU and also at global level with the main stakeholders' programmes.

The JRC is also paying the appropriate attention to the policy needs of the Commission and other European services like EEAS, providing support to the implementation of related policies and initiatives.

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.

4.2. How did the EU intervention make a difference?

The European added value of nuclear research is explicit in the Euratom Treaty⁽²³⁾ itself and the Commission has an obligation to put forward an R&D programme to complement those in Member States. The Euratom intervention is grounded mainly on the need to ensure high and uniform levels of nuclear safety, nuclear safeguards and radiation protection in Europe.

The EU added value of the direct actions of the Euratom programme is based on the JRC's unique strengths. Being part of the European Commission, and therefore independent from private and national interests, in association with its long scientific experience, the JRC is in the unique and appropriate position to provide scientific and technical support to other Commission services in the preparation, implementation and monitoring of the EU policies.

Expert panel evaluation report

By building and maintaining competencies in nuclear security, safety and safeguards, the JRC activities have served both the EU and Member State policymaking.

⁽²³⁾ 2012/C 327/01 Consolidated version of the Treaty establishing the European Atomic Energy Community, (Articles 2, 4, 7, and Annex 1)

The JRC provided technical and scientific support to the European Commission in the **implementation of policies like the Nuclear Directives**, (Nuclear Safety ⁽²⁴⁾, Basic Safety Standards ⁽²⁵⁾, Nuclear Waste ⁽²⁶⁾ and Shipments of radioactive waste ⁽²⁷⁾ Directives) and Instruments for collaboration (Instrument for Nuclear Safety Cooperation ⁽²⁸⁾ and Instrument contributing to Stability and Peace ⁽²⁹⁾). It has also provided support to the CBRN Action Plan ⁽³⁰⁾ or the dual use goods export control regime ⁽³¹⁾.

The Chapter 7 of the Euratom Treaty established the Commission obligation related to **safeguards of nuclear materials**. The direct actions of the research programme have been developing the necessary knowledge allowing to provide the scientific support for the fulfilment of this obligation. The JRC provided essential technical support to the nuclear safeguards system of the EU ⁽³²⁾ and to the EC support programme to the IAEA. An intensive and long-lasting collaboration is carried out with EU Member States through the operation of ESARDA (European Safeguards Research and Development Association) to the direct benefit of the EU and its Member States.

The direct research carried out by the JRC supported the harmonisation of the measurements of **radioactivity on the environment** in the EU and abroad and provided the appropriate techniques and reference materials to fulfil obligation of implementing the articles 34 and 35 of the Euratom Treaty.

The support provided in the implementation of the legislation was only possible due to the excellent and longstanding reputation the JRC has acquired and the knowledge developed through the Euratom research programme.

Other examples of evident EU added value were:

- The **Clearinghouse on Operational Experience Feedback** ⁽³³⁾ (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 and neighbour countries (Switzerland, Ukraine) operating nuclear power plants.
- The projects providing **open access to the JRC infrastructures** ⁽³⁴⁾, which are unique in the EU and allow the users to perform experiments with real radioactive materials that would not have been possible otherwise.

⁽²⁴⁾ Council Directive 2014/87/EURATOM establishing a Community framework for the nuclear safety of nuclear installations

⁽²⁵⁾ Council Directive 2013/59/EURATOM laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation

⁽²⁶⁾ Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

⁽²⁷⁾ Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel

⁽²⁸⁾ Council Regulation (EURATOM) No 237/2014 establishing an Instrument for Nuclear Safety Cooperation

⁽²⁹⁾ Council Regulation (EU) No 230/2014 establishing an Instrument contributing to Stability and Peace

⁽³⁰⁾ COM(2009) 273 final Communication on Strengthening Chemical, Biological, Radiological and Nuclear Security in the European Union – an EU CBRN Action Plan

⁽³¹⁾ Regulation (EC) No 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items

⁽³²⁾ Commission Regulation (EURATOM) No 302/2005 on the application of Euratom safeguards

⁽³³⁾ Ballesteros Avila A, Fernandez Andujar B, Ioakeimidou M, Novackova M, Peinador Veira M, Pla Freixa P, Simic Z, Strucic M and Tanarro Colodron J. Clearinghouse on Operating Experience Feedback. Petten (The Netherlands): European Commission - Joint Research Centre; 2017. JRC107114

⁽³⁴⁾ Schillebeeckx, P., Aregbe, Y., Gál, A., Heyse, J., Hult, M., Kopecky, S., Nyman, M., Oberstedt, S., Paradela Dobarro, C., Plompen, A. and Sibbens, G., EUFRAT, Open Access to the nuclear research infrastructure at JRC Geel, EUR 29582 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-98430-3, doi:10.2760/798329, JRC114118

- The **EU Security Training Centre** ⁽³⁵⁾, which provided training in nuclear safeguards and security to front-line officers. The syllabuses of these trainings have evident added value as they allowed a comprehensive view and harmonised understanding, including exchanges with other important external actors in the field, such as US DoE or IAEA and cannot be carried out in any other place.
- Euratom participates in the **Generation IV** ⁽³⁶⁾ International Forum to foster cooperation on research on the next generation nuclear technologies. The JRC, as the Euratom implementing agent, coordinates Euratom's technical and scientific contribution to Generation IV, which can stem from JRC direct actions. The European Commission Directorate for Research and Innovation funded indirect actions and EU Member States direct contribution.

4.3. Is the intervention still relevant?

The Euratom Treaty makes the Commission responsible for complementing the nuclear research carried out in the Member States with a Community research programme. The programme, therefore, is implementing a legal obligation.

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, aiming to potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way.

Moreover, the Communication “A clean Planet for all” ⁽³⁷⁾ considers an objective for reduction of greenhouse gas emissions for 2050, with an energy mix that includes a share of 15 % of nuclear energy combined with renewables and forming the backbone of a carbon-free European power system. To achieve this objective, there is no question that the highest standards of nuclear safety and safe and responsible nuclear waste management, as well as nuclear safeguards and nuclear security must be maintained.

The research carried out on nuclear materials is laying the basis to ensure the safety for the long term operation of the existing fleet of nuclear power plants, and also allows to ensure the safety of new designs as the small modular reactors. Research on high burn-up of fuels and on accident tolerant fuels allows the safer operation of nuclear power plants (NPPs).

The reference data obtained are feeding the Nuclear Data Libraries, allowing a safer use of nuclear energy and an adequate radiation protection for non-energy uses of radioactivity.

At the same time, to maintain these standards and to decommission the existing NPPs, as well as to build new ones in those Member States that choose the use of nuclear power in their energy mix, it is essential to maintain and enhance the capacity and knowledge in Europe. Therefore an intervention, at EU level, to foster the education and to train specialist continues being relevant. It is also relevant for those Member States that decide not to use nuclear power, as they are still using radioactive materials, for instance, for medical purposes, and should also be protected against security risks.

⁽³⁵⁾ https://joint-research-centre.ec.europa.eu/laboratories-and-facilities/european-nuclear-security-training-centre_en

⁽³⁶⁾ https://www.gen-4.org/gif/upload/docs/application/pdf/2021-06/gif_2020_annual_report_2021-06-29_16-45-14_170.pdf

⁽³⁷⁾ COM(2018) 773 final, A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy

Nuclear research capacities and expertise in Europe are vital for its strategic energy independence. The JRC has a key role in building competencies in the field of nuclear safety and security, knowledge management and providing technical facilities to support Member States and the EU policymaking.

The JRC provided open access to scientist of 84 Institutions of 23 countries, in the period 2014-2020, producing 140 scientific papers published in high impact peer review journals and allowed essential experiments for 64 PhD theses. Having in mind the high relevance of this “open access” project, an agreement to combine direct and indirect actions of the programme was reached in 2019. The agreement allows to continue the project further, enhancing the scope to more potential users and opening more laboratories for the external use. Although the project has been successful in the previous period, maintaining the EU competences is still highly relevant and an objective of the following Euratom programme 2021-2025.

In the period, 2014-2020, EUSECTRA was being developed, becoming a JRC’s flagship and instrumental for the nuclear security in the EU and globally. During this period, more than 1.600 front-line officers, law enforcement experts and nuclear measurement experts from 89 countries attended trainings.

In May 2022, the JRC celebrated 30 years of research on nuclear forensics ⁽³⁸⁾, with the participation of representatives of the main stakeholders and cooperating Institutions, such as US DoE, IAEA, CEA (France), BfS (Germany) or ANVS (The Netherlands). These stakeholders highlighted the relevance of such a long standing collaboration and the need for continuation of the support provided in the future.

In the field of medical applications of ionising radiations, considering the critical situation of the supply of radioisotopes in the EU, the JRC, with long expertise in the handling of radioactive nuclides for cancer treatment, investigated alternative production routes and isotopes for both diagnostic and treatment in nuclear medicine. The JRC participated in the EU Observatory on the supply of medical radioisotopes, drafted the reports on “Sustainable and resilient supply of medical radioisotopes in the EU” ⁽³⁹⁾ and participates in the SAMIRA ⁽⁴⁰⁾ action plan.

It can be, therefore, concluded that the programme at large was and continues to be relevant to cope with the existing needs. The necessary adjustments during the period were considered in the development of the bi-annual working programmes implementing the Euratom programme. This maintained the relevance allowing to answer properly to the changes on the landscape of the nuclear area.

JRC scientific and policy work can be accessed via the JRC Publications Repository of the EU Science Hub (<https://publications.jrc.ec.europa.eu/repository/>).

5. WHAT ARE THE CONCLUSIONS AND LESSONS LEARNED?

5.1. Conclusions

The evaluation of the direct actions of the Euratom programme 2014-2020, has confirmed the key role of the JRC for nuclear safety, security and safeguards research in Europe, as well as for building

⁽³⁸⁾ https://joint-research-centre.ec.europa.eu/events/keeping-europeans-safe-30-years-nuclear-forensics-2022-05-19_en

⁽³⁹⁾ SMER study on sustainable and resilient supply of medical radioisotopes in the EU, Diagnostic radionuclides ISBN 978-92-76-49317-4 and Therapeutic radionuclides ISBN 978-92-76-44467-1

⁽⁴⁰⁾ SWD(2021) 14 final; COMMISSION STAFF WORKING DOCUMENT on a Strategic Agenda for Medical Ionising Radiation Applications (SAMIRA)

competencies and providing expertise and technical facilities, in support of Members States and EU policies.

Based on the findings, supported by the assessment made by the external panel of experts, it was concluded that the JRC direct actions are instrumental in promoting the research and training in nuclear field in Europe and tackling the related challenges. The JRC has provided independent scientific and technical evidence in support of the EU policies and meets EU Member States needs in the field of nuclear safety, security and safeguards. The quality of the work is excellent, the JRC's scientific record of publication is good, the scientific value of the publication is comparable to the most recognised institutions in the field, and the goal to publish the scientific work openly is beneficial for the scientific community.

The direct actions of the Euratom programme, carried out by JRC contributed to improve the safe use of nuclear and radioactive materials in existing and future nuclear facilities, and in the management of nuclear waste, both in the EU and abroad. It provided scientific support to the nuclear safeguards and non-proliferation systems in the EU, as well as enhanced the nuclear security capacities. The results obtained were of high quality and scientific value, supporting the implementation of EU policies.

The effectiveness of the programme is comparable to other research institutions in terms of staff ratio devoted to support function. The scientific performance is well above the average and ranks amongst peer organisations and the impact achieved met the expectations. The external panel had concluded that the JRC should develop indicators to measure the efficiency in a clear and transparent way, as the comparative study carried out required an expert judgement; a new set of key performance indicators was therefore proposed for the Euratom programme 2021-2025, which should allow for a more suitable monitoring of the programme.

One of the aims that the JRC has been pursuing is to promote coherence of the programme across its several research areas, between the direct and indirect actions of the Euratom programme and with national nuclear research Programmes. The JRC participated in indirect actions of the programme, collaborated with national research institutions and participated in research platforms to obtain synergies and enhance the impact obtained.

The programme is highly relevant and has an important EU added-value, as the JRC provides not only high level of knowledge and experience, but also infrastructures, sometimes unique and always very scarce in the EU and it is able to deliver studies independent of any national or economic interest. Several non-exhaustive examples of the importance of the JRC carrying out the direct actions of the programme are:

- The JRC participated in about 45% of the projects granted under the indirect actions, highlighting the synergy between both strands of the programme. The JRC contribution to some of them was very important and being one of the main partners, that participation was even essential to some of the projects.
- The scientific and technical support provided by JRC to other Commission departments to prepare, implement and monitor EU policies, was possible thanks to in-house expertise developed through the direct research of the Euratom programme. One example is the Technical assessment of nuclear energy for the Taxonomy Regulation ⁽⁴¹⁾.
- 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. The JRC supports technically the fulfilment of the Commission obligation to manage a nuclear safeguards system ⁽⁴²⁾ in the EU and the EC support Programme to the IAEA.

⁽⁴¹⁾ EUR 30777 EN, Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852

⁽⁴²⁾ Euratom Treaty Chapter 7, (2012/C 327/01)

- The JRC education and training activities are fundamental to develop skills and capacities in the less advanced countries in this field. The JRC open access programme allows the use of the most advanced experimental facilities to institutions and countries that otherwise cannot have access to this kind of experiments. The European Nuclear Security Training Centre (EUSECTRA) develops nuclear security capacities for front-line officers contributing to increase the security level in the EU.

Due to its specific size and determined resources allocated, there are some inherent limitations to the programme. Limited resources have a direct impact on the JRC's ability to participate in all or most of the indirect actions projects, resulting in a necessarily selective approach and preventing full cooperation with all Member States research institutions. This means that the level of collaboration with the different Member States varies in intensity. The external assessment also signalled a need to incorporate more social sciences components into the nuclear research for a more integrative approach.

5.2. Lessons learned

Out of several recommendations put forward by the panel of experts, some are considered particularly important for the JRC to further address, such as several aspects of Small Modular Reactors, the support to decommissioning operations complementing the management of knowledge gathered in the frame of the existing decommissioning programmes or the new needs introduced by the long-term operation of nuclear reactors. The JRC's open access programme achieved very important results and new opportunities might also be created.

Amongst other recommendations which merit further exploring is the integration of social sciences disciplines in some Euratom activities like risk assessment or emergency preparedness and response. External experts have recommended that the JRC complement its ability to adapt to changing situations and urgent needs with the development of cross-cutting foresight capacities. They also recommended investing more on communication and making JRC high quality scientific assessments, data and databases more readily available. These are particular points which have been noted internally and echoed in a new nuclear strategy launched in 2022.

Indeed, the JRC started in 2021 to develop a strategy for its Euratom programme, taking into account the lessons learnt in the implementation of the framework programme 2014-2020 and the experience previously accumulated. It was presented to the JRC Board of Governors, seeking for its advice. This strategy, while reducing the risks, is providing an opportunity for improvement in the factors considered in this report: relevance, coherence and added-value of the programme and efficiency and effectiveness in its implementation.

The JRC strategy for its nuclear activities establishes the principle for prioritisation and consolidation of its activities and infrastructure. It consists of Key actions, developed in an action plan, which includes a roadmap for implementation.

Key Actions

1. Prioritise and realign current and prospective projects/activities
2. Enhance active collaborations with non-nuclear domains
3. Improve communication on the JRC nuclear activities
4. Enhance strategic cooperation with EU Member States
5. Select areas of cooperation with international partners
6. Maintain and develop critical competencies
7. Streamline knowledge management
8. Concentrate and cluster the nuclear experimental infrastructure of the JRC
9. Ensure coherence between nuclear site developments and the Decommissioning and Waste Management (D&WM) programme

In accordance with the findings of the external panel of experts, based on the lessons learned from of the Euratom programme 2014-2020 and after a period of internal reflection, various issues were identified and included in the strategy developed by the JRC ranging from anticipation to setting priorities, holistic approach, communication, capacity building and preservation.

Specifically, for the Euratom research, priorities will be set on investing in communication, developing foresight activities and strengthening the competencies in some fields such as small modular nuclear reactors or decommissioning. These aspects are considered as very important in the strategy and JRC will address them enhancing the communication and cooperation with partner institutions in EU Member States, international organisations and partners, while striving to maintain the existing competences and developing new ones to face futures challenges.

ANNEX I. PROCEDURAL INFORMATION

- *Lead DG:* Joint Research Centre
- Decide reference: PLAN/2022/2284
- *Programme:* Euratom research & training programme 2014-2018 and 2019-2020
- *Organisation and timing:* the Euratom programme 2014-2020 requests separate evaluations for the direct and indirect actions of the programme. The internal evaluation of the Programme, based on the inputs received, started in September 2022, holding coordination meetings with RTD who leads the report on evaluation of indirect actions.
- *Evidence used:* The data contained in this report, related to number of outputs delivered are based on the internal JRC databases of publications and other outputs (PUBSY), on data of internal monitoring as the yearly exercise PRIME, and other management and monitoring systems.
- *Quality assurance:* The JRC organises its activities following an Integrated Management System compliant with the requirements of several standards, requirements originating from the European Commission, international and national legislation, Commission regulations and rules. The JRC Quality Management System integrated in the IMS is compliant with the requirements of the ISO 9001:2015 and integrates the European Commission level requirements.
- *External expertise:* The evaluation report of direct actions is based on 12 impact assessment case studies of activities focused on all the programme objectives carried out in 2021, which included the feedback of customers and stakeholders and were evaluated independently. An external expert's panel carried out a thorough assessment of the JRC's performance on the programme in the first half of 2022, which is the main input on which this report drew its evaluation; the experts' assessment report contains a series of recommendations for the JRC and also in relation with the Euratom programme which were also reviewed, reflected upon and in part feature in this report.

ANNEX II. METHODOLOGY AND ANALYTICAL MODELS USED

Purpose: This evaluation aimed to assess the performance of the JRC direct actions throughout the seven years of the Euratom programme 2014-2020 and the achievements obtained, as well as to provide forward looking recommendations.

Methodology: The evaluation was conducted with the support of an external panel of experts and based on the results of their review and conclusions, the European Commission has drawn its own ex-post evaluation of the Euratom programme.

A new methodology for impact analysis of JRC work has been developed. It is grounded in a structured, multi-dimensional assessment of case studies, wherein the impacts on policy-making, public debate, science, and society are considered. 12 case studies representing activities covering a broad spectrum of the Euratom programme objectives were selected and drafted based on the feedback on stakeholders before being carefully assessed by a panel of external independent evaluators. They consisted of members from academia, business, NGOs and national ministries with expertise in the topics covered. The cases, the metadata and the evaluation results are then analysed to provide a deeper understanding of the value of the JRC's work programme, the JRC as an organisation and of its parts. The results of the external experts' assessment then fed into this ex-post evaluation of the Euratom programme 2014-2020 direct actions.

Moreover, the JRC Productivity and Impact Evaluation (PRIME), as the annual corporate-wide assessment of the productivity and policy support impact generated by JRC scientific projects and their outputs, serves as a good metric to assess performance and has been used in this evaluation.

- External panel of experts: The panel, made up of 15 members, examined the direct actions, conducted by JRC, under both Horizon Europe and Euratom Programmes during the period 2014-2020. Out of the 5 thematic areas analysed the one on nuclear safety and security was evaluated by a sub-panel of 3 members, experts in the area of nuclear engineering and waste management, assisted by other panel members and the chairman for more horizontal aspects. The assessment was built on available background documents, activity reports, bibliometric analysis provided by JRC, complemented with the presentations of the sites and interviews with staff members and stakeholders. The final report was delivered in July 2022, discussed with the JRC senior management and, in November 2022, presented to the JRC Board of Governors.

Limitations: due to the pandemic of covid-19 still at the beginning of 2022, it was not possible to visit JRC sites and meet with the staff, therefore visits were replaced by a set of presentations and videos of selected laboratories as well as virtual interviews conducted with selected staff members.

JRC documents: General reports (Annual Activity reports), Fact & figures of the JRC report, Stakeholders surveys, Scientific excellence 2014-2020 report, Case studies of JRC's impact, PRIME report 2014-2020.

ANNEX III. EVALUATION MATRIX AND, WHERE RELEVANT, DETAILS ON ANSWERS TO THE EVALUATION QUESTIONS (BY CRITERION)

Criteria	Question	Answer	Indicator	Data source
Relevance	Was the programme designed and implemented in line with the needs of EU policy makers, in particular the political priorities of the Commission 2014-2020 ?	There are clear links between policy priorities and the JRC's programming, results and impact	Number of outputs producing an impact on the EU policies (85% of the target)	JRC's PRIME report
	Did the JRC anticipate, and react appropriately to new policy needs and societal challenges?	The JRC reacted well to new policy needs, societal challenges and technological developments Thanks to its broad competence base and its specific mission to support policymaking, the JRC is also able to adapt to changing situations and urgent needs.	Ex: fast reaction to the accident in Fukushima supporting the EU stress test and to nuclear safety issues related to COVID-19 pandemic	
	To what extent did the JRC reach its goal of becoming a strategic partner and more central to EU policy making?	The JRC appropriately responded to policymakers' needs		Dedicated impact case studies
Effectiveness	Contributed to meeting the overall and specific objectives of Euratom 2014-2020?	The JRC has provided effective support to policymaking and produces research of internationally recognised scientific quality. In particular, related to the Euratom programme, the JRC has provided independent scientific and technical evidence	<ul style="list-style-type: none"> – Policy support indicator: 85% of the target – Scientific productivity indicator: 103.6% of the target 	<ul style="list-style-type: none"> – JRC's presentations and documentation provided. – Dedicated impact case studies. – JRC bibliometric analysis and scientific impact indicators

		and the quality of the work was excellent.		
	Are the JRC's processes for planning, monitoring, reporting and evaluation appropriate, effective and transparent?	<p>The JRC should use more holistic approaches in designing its work programme. It should give anticipation a high priority, allocating sufficient resources and setting up a governance structure to optimise the efforts. The JRC should develop a customised communication strategy.</p> <p>The JRC should review the indicators for measuring impact, recommendations encourage the JRC to pursue the case study approach</p>		External panel report
	Has the JRC followed the recommendations of the ex-post evaluations 2006-2013 and the interim evaluations 2014-2017?	Stakeholders have noted that the effectiveness of interactions with the JRC and its policy relevance have further improved during 2014-2020.	Policy impact case studies collected feedback from partner DG's and stakeholders	
Efficiency	Has the JRC's funding as a whole been sufficient to achieve its Euratom objectives?	The panel noted some stakeholders' concern about the reductions affecting the Euratom research and training programme.		Expert panel report
	Has the JRC attributed the funding effectively (in terms of	The JRC provided evidence of shifts in staff allocation based on		

	output, quality of research and impact)?	criteria such as political priority, availability or operational maturity.		
	Has the JRC implemented its work programmes in a cost-effective manner?	<p>The JRC analysed the cost-effectiveness of the results obtained requiring highly expert knowledge to do it.</p> <p>The JRC should develop clear key performance indicators to measure its efficiency.</p>		JRC interim report: Cost-effectiveness analysis
Coherence	<p>How coherent are the direct actions in terms of synergies, overlaps and complementarities with:</p> <ul style="list-style-type: none"> indirect actions? Are the respective roles and terms of interactions sufficiently clear and efficient? the EU programmes serving objectives similar to those of the framework programmes? relevant national or international initiatives? 	<p>A number of the JRC's Euratom programme activities are being carried out in collaboration with international organisations like the International Atomic Energy Agency (IAEA) and the OECD/Nuclear Energy Agency (NEA) and with national EU Member States' nuclear research programmes, as well as internationally, e.g. with the US and Japan</p> <p>The JRC's open access policy promotes the coherence between direct and indirect actions, also with national programmes.</p> <p>The JRC's participation in indirect actions complements its direct actions.</p>	Participation of JRC in Indirect actions under the Euratom programme	Report JRC 126728
	To what extent has JRC achieved its aim of greater	There is still a high degree of fragmentation between the		Expert panel report

	interdisciplinarity and more internal cooperation for policy support?	nuclear and non-nuclear activities. While there are strong ties with other organisations, exploiting the potential for synergies and applying more holistic approaches within the JRC and the Commission seems less developed.		
EU added value	To what extent does the JRC research and policy support provide added value beyond what is being done in Member States?	<p>The Programme stems from the Euratom Treaty, which made the Commission responsible for implementing Community research and training programmes.</p> <p>By building and maintaining competencies in nuclear security, safety and safeguards, the JRC activities have served both the EU and Member State policymaking</p>		
	What would have happened if the direct actions had not existed? Could the stakeholders have reached their objectives through other means?	The role of the JRC in supporting and developing nuclear safeguards and non-proliferation is essential for any current and future nuclear fuel cycle facility, in Europe and globally.		
Additional evaluation criteria A FORWARD LOOK	What are changes in priorities, organisation, processes or working methods that could be made in order to further enhance the agility, impact and	It is of vital importance to maintain the special infrastructures of the JRC and at the same time to prioritise the research topics that cover all		

	<p>efficiency of the JRC's policy support?</p>	<p>safety and security of nuclear energy production, waste management and non-energy uses.</p> <p>Increasing cooperation with third parties could provide solutions for dealing with capacity or competence gaps.</p> <p>The ability to respond quickly to unknown events, calls for skilled staff, data and codes to be available for the use of the EU.</p>		
--	--	---	--	--

ANNEX IV. OVERVIEW OF COSTS AND BENEFITS IDENTIFIED IN THE EVALUATION

Table 1. Overview of costs and benefits identified in the evaluation ⁽⁴³⁾						
	Citizens/Consumers		Administrations ⁽⁴⁴⁾		Euratom 2014-2020 beneficiaries	
	Quantitative	Comment	Quantitative	Comment	Quantitative	Comment
Costs (not applicable to Joint Research Centre)						
<p>Mark the type of cost/benefit, each on a separate line:</p> <p>Costs:</p> <p>Direct compliance costs (adjustment costs, administrative costs, regulatory charges)</p> <p>Enforcement costs: (costs associated with activities linked to the implementation of an initiative such as monitoring, inspections and adjudication/litigation)</p> <p>Indirect costs (indirect compliance costs or other indirect costs such as transaction costs)</p>	one-off			<p>454 473 000</p> <p>JRC Staff expenditure (permanent and non-permanent staff salaries ⁽⁴⁵⁾)</p> <p>249 043 000</p> <p>JRC Running costs and investments (small/medium)</p>		

⁽⁴³⁾ Where there is a prior impact assessment, the table should contain as a minimum the costs/benefits identified in the IA with the information gathered on the actual cost/benefit. As available, the table should include the monetisation (€) of the costs/benefits based on any quantitative translation of the data (time taken, person days, number of records/equipment/staff etc. affected or involved represented in monetary value – see Standard cost model, for example). For all information presented, it should be included in the comments section whether it relates to all Member States or is drawn from a subset. An indication of the robustness of the data should be provided in Annex II on Methodology and analytical models used.

(⁴⁴) JRC budget for major infrastructure and scientific expenditure is not included

⁽⁴⁵⁾ JRC's expenditure for staff is not just a cost, it also brings added-value as it pays actual researchers to conduct direct actions research, not only administrative overheads.

Benefits							
Indirect benefits for EU society from scientific impact & related benefits to participants			<p>Euratom 2014-2020 strengthened frontier research in the nuclear field, contributed to scientific breakthroughs and advancements. It strengthened capacities and skills of researchers through furthering EU-wide career development and access to research infrastructures.</p>				<p>1. Peer-reviewed publications</p> <p>Over the 2014-2020 period, the JRC achieved 1076 peer-reviewed publications, reaching 92% of the set target.</p> <p>Target: 1170</p> <p>2. Tangible impacts on policymaking</p> <p>Over the period, JRC achieved 85% of the set target by delivering outputs in support to EU policies which generated 373 tangible impacts on policymaking.</p> <p>Target: 440</p> <p>3. Open access to nuclear infrastructures</p> <p>Over the period, JRC provided access to its facilities to scientists</p>

							<p>originated from 84 institutions from 23 different countries, which resulted in 140 scientific papers published in high impact peer-reviewed journals and 64 theses.</p> <p>4. Trainings</p> <p>Over the period, the JRC conducted 154 training, including through the EUSECTRA flagship initiative on safeguards, which contributed to train over 1600 front-line officers, law enforcement experts and nuclear measurement experts from 89 countries.</p> <p>5. Scientific and policy outputs</p> <p>Over the period, the JRC delivered 50 science for policy reports, 1064 technical reports, 34 reference materials and made 49 contributions to policy documents and 31 contributions to standards.</p>
--	--	--	--	--	--	--	--

ANNEX V. STAKEHOLDERS' CONSULTATION - SYNOPSIS REPORT

The Quality Management System integrated in the JRC's Integrated Management System ⁽⁴⁶⁾ is compliant with the requirements of the ISO 9001:2015. One of the requirements is the communication with stakeholders and other interested partners, aiming to exchange information on the knowledge production and management processes, handling enquiries, obtaining feed-back and establishing specific requirements.

To determine the requirements related to products and services, JRC consults bilaterally with its stakeholders. Related to its specific objective of provision of support to the EU policies, the JRC submits its work programme to an Interservice Consultation process.

Regularly, JRC collects the feed-back of stakeholders on the products and services provided, following the established procedure in the Quality Management System ⁽⁴⁷⁾. The questions asked related to the understanding of the partner's needs, timeline, effective communication, JRC's scientific expertise, quality of deliverables, added value and overall satisfaction. 67% of the answers received showed a high level of satisfaction and 33% were satisfied enough with the support provided. All the stakeholders that answered will continue using the JRC services in the future.

The impact case studies presented in the report which highlight activities spread over all the specific objectives of the Euratom programme were selected and validated based on the positive feed-back collected from corresponding stakeholders and evaluated by external experts. This has also formed part of the stakeholders' consultation for the purpose of the evaluation.

The JRC has frequent interactions with external stakeholders as part of its participation in research consortia under the indirect actions of the Euratom programme, as well as through different collaboration instruments with partners from the EU, third countries and international organisations.

The JRC also maintains constant contacts with its external EU stakeholders, notably by being a member or observer of technology platforms like SNE-TP (Sustainable Nuclear Energy Technology Platform), which gathers over 140 nuclear research actors in Europe and IGD-TP (Implementing Geological Disposal of radioactive waste Technology Platform), which gathers a similar number of entities in the EU and beyond. This ensures alignment of the JRC's work programme with the research carried out by EU stakeholders and guarantees regular engagement with them. JRC also cooperated with the European Energy Research Alliance (EERA)-Joint programme on Nuclear materials, EURAD – European Joint Programme on Radioactive Waste Management, and with the European Nuclear Education Network (ENEN) association Holding the secretariat of and being part to ESARDA (European Safeguards Research and Development Association) also allows JRC activities in nuclear safeguards and non-proliferation to be fully aligned with the challenges identified.

This enables the JRC to receive continuous feedback which provides useful inputs shaping the JRC work programme.

⁽⁴⁶⁾ JRC Integrated Management System – Manual IMS-JRC-M4.1-MAN-0001

⁽⁴⁷⁾ Partner and Stakeholder feedback - IMS-JRC-M3.1-PRO-0009