Ex post evaluation of the activities of the Joint Research Centre

under **Horizon 2020** and **Euratom 2014-2020**

FINAL REPORT OF THE *EX POST* EVALUATION PANEL

JULY 2022

Joint Research Centre

EU Science Hub
https://joint-research-centre.ec.europa.eu

JRC130367

PDF ISBN 978-92-76-55600-8 doi:10.2760/257315 KJ-07-22-791-EN-N

Luxembourg: Publications Office of the European Union, 2022

How to cite this report: 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, doi: 10.2760/257315, JRC130367.

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Foreword by the chair and the vice-chair

In 2021, the European Commission launched the ex post evaluation of the direct actions within the research framework programme Horizon 2020 and the Euratom research and training programme (and its extension) for the period 2014 to 2020. We had the honour and pleasure to chair a Panel of diverse independent external experts with experience from evaluations of other knowledge organisations and research programmes.

In this report, we present our observations and recommendations. We came to a very positive assessment of the performance of the JRC which has developed well during the period in question. Although most of the scientific work is more geared towards applications, we would like to commend the JRC for giving its researchers the opportunity to do 'blue sky' research. Given that overall positive impression, we decided to concentrate in the report on elements on which the JRC could make additional steps to further improve.

The JRC is in a unique position as a provider of independent scientific evidence inside the European Commission: this position allows or even mandates the JRC to ensure that policymaking is based on the best available scientific evidence and to contribute to policy coherence across different policy interests. But because of its position within the Commission, the JRC and its research work are less visible to the outside world than they merit. Both the European Union and the JRC would benefit from wider recognition of this work.

They would also benefit from more communication and interaction between different units in the JRC beyond the already visible progress. Although not within our mandate, the chairs suggest to the Commission to encourage more frequent interaction between different Directorate-Generals before charging the JRC and to involve the JRC earlier in framing policy questions. This would help the interactions between the different stakeholders become more effective. The Commission and the JRC doing this coherently would in our estimation constitute a further step forward for evidence-based policies. Another suggestion in this context to the Commission is to find an administrative way to facilitate the interaction between Euratom and Horizon Europe-financed activities. This may be all the more important given the challenging reductions in the Euratom budget for 2021-2027.

We commend the JRC on its support to policymaking during the severe restrictions on its sites imposed by the COVID-19 pandemic.

For our deliberations we found especially useful information channels not available in earlier reviews. The meetings with stakeholders gave much insight into the cooperation between the JRC and the other parts of the Commission, supporting our positive assessment and our suggestions for improvement. Also the meeting with the JRC top management and with the Ad hoc Group of the JRC's Board of Governors on 'Organisational Transformation' was important and insightful. The case studies presented by the JRC were very helpful, in particular as they presented input from external experts.

We greatly enjoyed working with so many distinguished colleagues on the Panel and we would like to thank them all for their commitment, their work, and their input. The Panel supports unanimously the report in front of you. On the behalf of all members, we want to thank everybody in the JRC involved in this review, in particular Jens Otto and Sari Lehto for

their constant support, help and patience, also well mastering the complications imposed by COVID and Annabelle Kasiers for all the administrative preparations.

Executive summary including the main recommendations

A Panel of external experts has conducted the *ex post* evaluation of the JRC's direct[1] actions under Horizon 2020, the framework programme for research and innovation, and the Euratom research and training programme 2014-2020. This evaluation report presents the Panel's observations and comments on the JRC's past performance, together with a number of key recommendations and suggestions for the future. The review was performed along impact areas defined for the *ex post* evaluation of the entire programmes. However, here we summarise the overall recommendations only, cutting across all impact areas. The recommendations concerning individual impact areas are presented in the relevant sections.

The evaluation took place between the autumn of 2021 and summer 2022, while restrictions due to the COVID-19 pandemic for travel and personal contacts were still in place. Despite this, the online meetings, virtual visits and two site visits gave the panel sufficient opportunity to develop its findings. The Panel was able to interview some of the key stakeholders of the JRC in the European Commission (policy DGs and cabinets) and the European Parliament, and this novel feature enriched the Panel's findings.

In its work, the panel took into account the recommendations of the previous *ex post* and *interim* evaluations, and the follow-up that the JRC has given to them.

The Panel commends the JRC for making strong efforts to implement the recommendations of previous external evaluations. These efforts have already been bearing fruit and the Panel looks forward to the JRC continuing the good practice of reporting back on the progress made in implementing such recommendations.

The Panel found **clear links between policy priorities and the JRC's programme planning results and impact**. The JRC has made important contributions to key policy goals and contributed significantly to the Commission's working methods and funding instruments. It has reacted well to new **policy needs, societal challenges and technological developments**, developing several new activities and phasing out some others that were considered less relevant or had reached operational maturity.

The JRC produces research of internationally recognised scientific quality. In terms of bibliometric indicators, it ranks well among its comparators which include many leading academic institutions, research and technology

[1]The EU research and innovation funding programmes distinguish direct research actions, carried out by the European Commission's Joint Research Centre (JRC), and indirect research actions carried out at research centres, universities or enterprises, with partial financial assistance from the EU or Euratom research and innovation funding programmes. The JRC's direct actions accounted for approximately 2.5% of the total Horizon 2020 , and almost 35% of the Euratom, budget.

organisations, and organisations whose mission is similar at least in part to that of the JRC.

The Panel concludes that the JRC appropriately responded to policymakers' needs. It also concludes, in general, positively on its effectiveness 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.

While acknowledging the past performance, the Panel has identified a range of issues on which the JRC can make further progress.

Become more proactive in anticipating crises. The Panel has seen some examples of the JRC proactively stimulating policymaking, but this should become a standard practice. A more **proactive approach**, supported by foresight, could make the JRC more effective in helping to shape the policy agenda and make the Commission's policy work more future proof.

There has been progress in **foresight** activities, starting with ad hoc foresight studies co-designed with policy DGs in the JRC's policy lab, to the JRC's role as co-lead for the Commission's Annual Strategic Foresight Report. However, foresight should be embedded in activities across the JRC, as foreseen in the JRC Strategy 2030 as part of a stronger culture of anticipation.

> **The JRC should give anticipation a high priority, as foreseen in the JRC Strategy 2030, allocate sufficient resources and set up a governance structure to optimise the efforts.**

The **two concurrent crises during the evaluation process** (the COVID-19 pandemic and the war in Ukraine) made the Panel look closely at the JRC's role in crisis anticipation. The Panel recognises the JRC's quick response to various crises using many scientific disciplines, but urges the JRC to develop a more holistic and anticipatory approach. The EU could strongly benefit from the JRC's unique scope of scientific activities and cross-European perspective in anticipating future crises, within the limits of the existing relevant mandates in the EU.

> **The JRC should build capacities and tools to prepare for, and respond to, future shocks. To this effect, it should i.a. invest in collecting and maintaining data on past and future shocks.**

Attention should be paid to ensure that the anticipation and response mechanisms are designed to be agile and interdisciplinary, to cover a variety of potential shocks and to support the European Commission in taking advantage of the opportunities, which such shocks provide for accelerating the implementation of political priorities. Lessons learnt should be drawn and used to improve crisis preparedness and response.

Prioritise work for higher impact. The Panel was impressed with the broad range of the JRC's direct actions, but noted that there is room for better focussing the resources on activities with the highest impact, where the JRC has or can reach a critical mass and is uniquely positioned to provide the needed evidence.

> **The JRC should be involved at an early stage in the priority setting among policy DGs and establish a centralised process for ensuring that the work programme reflects these priorities and the breadth of knowledge needed to support the priorities. This process should also incentivise policy DGs and the JRC to break silos and integrate suitable workstreams.**

The Panel found good use of what are, in its view, the JRC's unique strengths; however, there were some examples where JRC's added value and role were less clear.

> **The Panel encourages the JRC to systematically develop and apply criteria in relation to its unique strengths and policy relevance for deciding whether or not to engage in a**

particular activity, and for disengaging from it.

Develop more holistic and broad multi- and inter-disciplinary solutions for policy priorities. The Panel acknowledges the JRC's efforts in tackling a perceived silo mentality, stimulating cooperation and inter-disciplinarity, e.g. with the creation of knowledge centres or structuring the work programme in thematic portfolios. Progress was also noted in integrating social sciences into the research. However, there is a need for more holistic, broad multi- and inter-disciplinary solutions for policy priorities, such as the twin green-digital transitions.

The JRC should use more holistic approaches in designing its work programme and response to policy needs, and develop, as part of its business model, a strategic plan for integrating social sciences.

This plan should include the recruitment of experienced social scientists with broad competences and networks and/or the setting up of a pool of experts the JRC could tap into to enhance its capacity for addressing social aspects in its policy support.

Make the most of JRC data. The JRC collects and uses a large amount of data to underpin its scientific evidence. This is an important part of its activity, and some of the data sets are unique. However, there appeared to be a lack of an overall strategy to drive the collection, integration and utilisation of data, which also hindered the effective use of data by third parties, such as universities or member state authorities and research organizations. The panel also felt that the databases should be used more for anticipation rather than for impact assessments, evaluations, or modelling with a fixed-time horizon.

The JRC should develop and implement an organisation-wide strategy to drive the collection, integration, utilisation and storage of data, to ensure data quality and regulatory compliance and build data governance capabilities to break data silos.

Make communication more effective. From its discussion with staff and the stakeholders in the policy DGs, and review of public web sites of the JRC, the Panel felt that there was an opportunity for improving **communication** at different levels, within the JRC (for better cooperation), the Commission (clarity on what JRC, and science more generally, can and cannot provide in terms of evidence for policymaking and with stakeholders (on the role and impact of JRC).

The JRC should develop a communication strategy to enhance its communication at different levels, customising it to different target groups, and using the most suitable channels (digital or traditional) to reach to such groups.

Develop and nurture the JRC workforce. The Panel noted the development of talent management programmes, and the progress made in some specific aspects, such as gender balance at middle management level. However, there continues to be lack of diversity, in particular gender balance and a skewed age structure in the JRC's management but also at the level of officials in general.

The JRC should implement a proactive talent acquisition approach at all levels of seniority, with the aim of establishing a more diverse workforce, in particular with regards to gender balance. This applies to external recruitment but also to suitable internal development programmes to incentivise and motivate potential candidates.

Monitor and promote impact and efficiency. The impact on science compares favourably with that of peer organisations, and external experts have rated the policy impact in

the majority of the assessed case studies as very significant.

At the same time, the Panel notes the limitations of quantitative proxies for measuring efficiency, impact and performance, in particular for evidence of the science to policy impact. Traditional statistics should be complemented with feedback from stakeholders on their actual use of scientific evidence in policymaking, with case studies and peer reviews.

> **The JRC should review the indicators for measuring impact, taking into consideration current Commission initiatives on reforming research assessment methodologies.**

The JRC has taken actions that can lead to **efficiency gains** by harmonising working methods and streamlining the organisation. The Panel also considers that resources were allocated and shifted broadly in line with political priorities. However, appropriate data are lacking making it difficult to assess the overall efficiency.

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

Improve the coherence of the work programme. In the presentations and discussions, there was sometimes a lack of links between different activities, be it between programmes (Horizon 2020 and Euratom) or within programmes and impact areas.

The Panel noted a high degree of fragmentation of activities in some cases within impact areas and programmes, but also between the nuclear and non-nuclear activities.

Use expert advice for charting the path of the JRC's developmen The recommendations cover a broad spectrum of working methods and research approaches. In the Panel's view, an **external group of eminent experts** would be a useful instrument to advise the JRC on issues such as priority setting, linking various programmatic areas and developing more holistic approaches. The role and mandate of such a group should be complementary to the established governance structure of the JRC.

> **The JRC should establish an external expert group to advise on strategic development, integration and priority setting of its activities.**

The **boundary conditions for Euratom-related activities for 2021-2027** call for additional remarks. The JRC has reported on significant budget cuts for the new Euratom research and training programme 2021-2027, with impact on both the infrastructure and the staffing. The Panel notes that maintaining the special infrastructures and capabilities of the JRC is important for preserving and ensuring EU autonomy for research on safety and security of nuclear energy production, waste management and non-energy uses.

Finally, the Panel would like to underline the usefulness of the **meetings with key stakeholders**. Their views stimulated the discussions of the Panel and confirmed many of the findings.

> **The Panel recommends to maintain interviews with stakeholders by the panels in future external evaluations under the framework programmes for research and innovation and the Euratom research and training programmes.**

Part 1 – Introduction

Legal basis for the evaluation

The Joint Research Centre (JRC) is the science and knowledge service of the EC to inform its policymaking. Most of its activities are financed in seven-year cycles through the EU research framework programmes (5 years for the Euratom research and training programme). This report provides an *ex post* evaluation of the JRC's direct[1,2] actions during the Horizon 2020 framework programme for research and innovation and the Euratom programmes for 2014-2020. It has been prepared by independent external experts, referred to as the Evaluation Panel (hereafter 'the Panel'), as requested by the Council and the European Parliament in the legal texts of both programmes[3].

Background on the JRC

Set up 60 years ago as a research body inside the European Commission, the JRC is wholly dedicated to the purposes of the European Union. It is thus unique with regards to its functioning, structure and institutional positioning. With an annual budget of close to EUR 400 million, the JRC accounts for approximately 2.5% of the annual budget of the Horizon 2020 framework programme, and this in turn represents less than 10% of the total public spending on research in the EU Member States. The JRC's share in the Euratom research and training programme is almost 35%.

The main data for the JRC during 2014-2020 are assembled in 'JRC's facts and figures', which is included as Annex 3 of this report. The timeline (Figure 1) lists some of the milestones in the JRC's history, showing in 1957 a nuclear research organisation, expanding in 1998 into other areas towards a mission 'to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle', and anchored in EU legislation today.

The evaluation of the JRC's performance during 2014-2020 has to be set against this history and its current mission statement.

[2] The direct research actions accounted for 80% of the JRC programme 2014-2020, the other 20% being work under contract.

[3] Regulation (EU) 1291/2013, Council Regulations (Euratom) 1314/2013 and 1563/2018

Timeline: mandate and mission of the JRC

1957 France, Germany, Italy, The Netherlands, Belgium and Luxemburg created the European Atomic Energy Community - Euratom, which provided them with: an instrument of industrial policy, energy policy; a scientific and technical research organisation in the nuclear sector - the JRC (article 8 of the Treaty); establishments around nuclear facilities in four of the founding Member States (Belgium, Germany, Italy and The Netherlands).

1971 Confronted with a waning interest for nuclear research the Commission reorganised the JRC. The idea that the JRC could be involved in non-nuclear research was accepted in principle at the First Summit Conference of the Enlarged Community of 1972 in Paris. The Summit allowed the Commission to start working towards a European policy for research.

1973 Council adopted the first JRC research programme for the European Economic Community (EEC) in parallel to the JRC's research programme for Euratom. The JRC began studying the e° ects of air pollution on citizens, the e° ects of chemical substances on the environment and started developing the use of satellite data from space, e.g. for monitoring agriculture and natural resources.

1984 Decisions from the 1972 Paris Summit matured into the First Framework Programme for Research, adding Community funding for research in the Member States ('indirect research') to the funding for the 'direct research' by the JRC. A Commission Decision on the JRC set up the Board of Governors as it operates today.

1989 Council decided that 'the Commission may place the installations, equipment or expert assistance of the Joint Research Centre at the disposal of third parties whether public or private, as appropriate, against payment'.

1996 The last Commission Decision on the reorganisation of the JRC, including the functions of the Board of Governors.

1998 Council approved the JRC's current policy-support mission in the legal text of the Fi¸h Framework Programme for research and technology development. Nuclear research remains the JRC's single largest area of technological competence.

2013 From this year onwards, the Commission formally approves the JRC's Work Programmes on an annual basis, reflecting the importance the Commission places on the JRC's projects. This was changed to a bi-yearly Work Programme from 2014 onwards.

The JRC's mandate stems both from the European Atomic Energy Community with the Euratom Treaty (1957 - never amended as to substance) and from the Treaty on European Union (2007).
The Treaties and the derived multi-annual research framework programmes determine the JRC's mandate and mission.

Figure 1. Timeline and main milestones in the JRC's history

Intervention logic

To clarify the JRC's objectives and to translate them into a hierarchy of intended effects, the JRC uses a graphic illustration of its intervention logic (Figure 1). It maps the relationships between the JRC's mandate as specified by the Council and the European Parliament, its activities and the desired effects thereof (i.e. output/deliverables and impacts), the objectives that the JRC works to and the purpose of the JRC as a whole in the EU.

This simplified view provides a background for the evaluation. The intervention logic highlights that the JRC has two main activities: scientific support to EU policies and related scientific research. This focused the Panel's attention on the importance of the right balance between directly supporting policymaking and performing fundamental research.

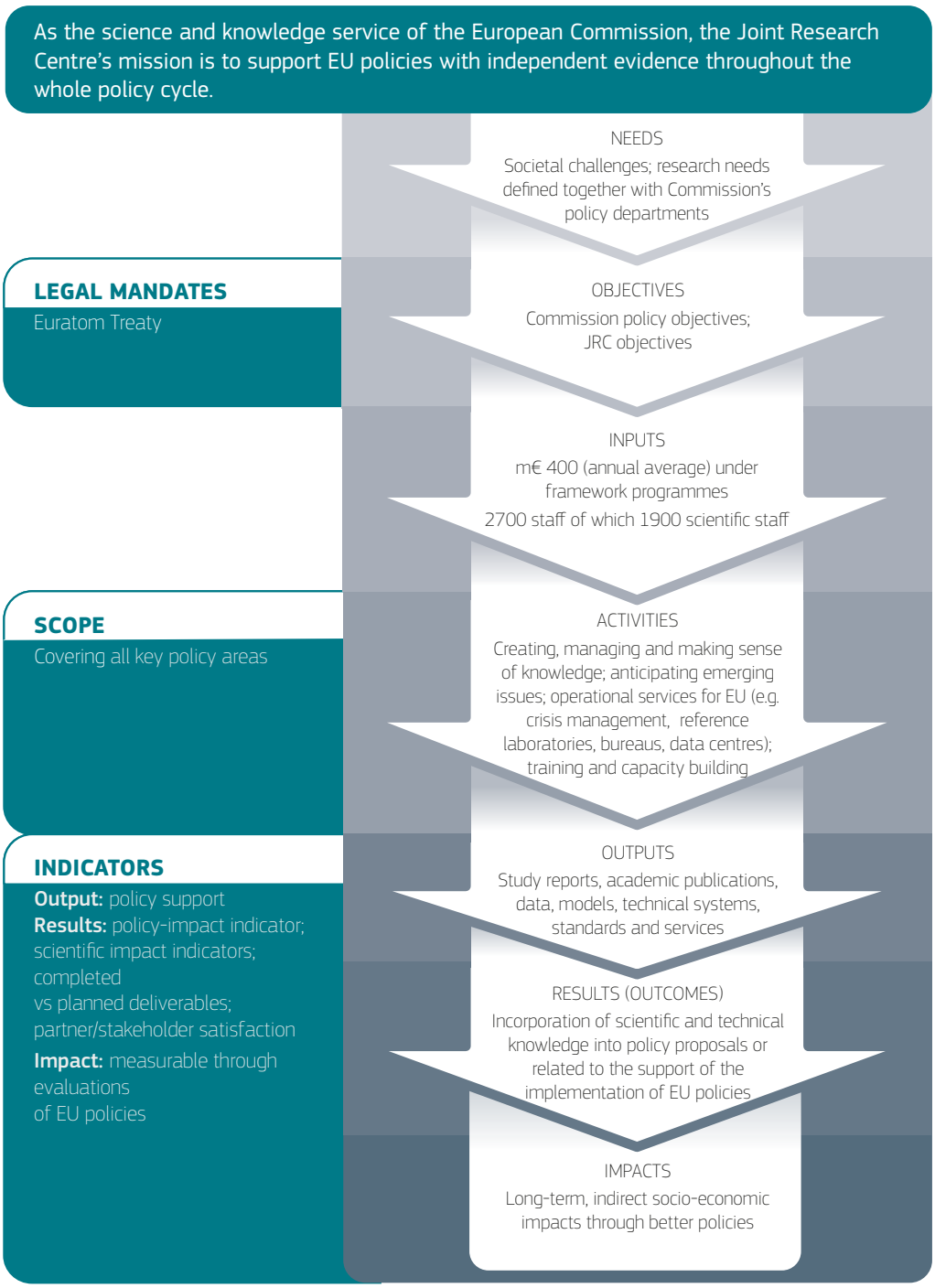

Figure 2. The intervention logic of the JRC.

Panel mandate

The evaluation process was aimed at reviewing and improving the relevance, efficiency, effectiveness and EU added value of the JRC, in line with the criteria stipulated in the Better Regulation Guidelines for *ex post* evaluations[4]. The terms of reference for this task (Annex 2) contain a list of evaluative questions which feed into the assessment of the performance of the JRC but which are not dealt with one by one.

The terms of reference also set out the 5 evaluation themes which were used to present the JRC's activities:

- Resilient Europe,
- Digital and industrial transition,
- Green transition,
- Innovative Europe,
- Nuclear safety and security (Euratom).

The evaluation themes are based on the 'impact areas' defined for the overall programme evaluation of Horizon 2020, with the addition of 'nuclear safety and security' to satisfy the requirements of the Euratom regulation for an evaluation dedicated to the nuclear activities of the JRC.

In refining its mission, the Panel concluded that, given the scope of the JRC's activities and the resources available to the Panel for its evaluation, its primary mission was to conduct a qualitative, high-level peer review of the JRC's performance within the relevant period, with recommendations for further improvements and without entering into a detailed assessment of each impact area. Nevertheless, the aggregation of activities under the impact areas allowed the Panel to also undertake a high-level thematic assessment as suggested by the *ex post* evaluation of the JRC in FP7.

Evaluation methodology

For a general view of the organisation and initial insights into its achievements, the Panel conducted desk research studying the legal bases, programme documents, performance reports, organisation charts and the organisation's public websites.

Additional documents provided to the Panel were reports on:

- the JRC's scientific productivity and performance 2014-2020 based on Elsevier's Scopus;
- impact on media, based on an analysis with a variety of public and JRC-owned tools;
- annual productivity and impact reports, based on a self-assessment;
- 50 case studies illustrating the impact of selected JRC activities on science, society and policymaking. These had been compiled by the JRC and evaluated by dedicated external panels before the start of the present evaluation. In addition, the feedback of the policy DG recipients of this work was collected through structured surveys;
- an internal *interim* evaluation of the scientific development programme;
- the JRC's performance under the 5 evaluation themes, compiled from the above reports and additional input from the directorates concerned.

The **fact-finding mission** consisted mainly of a series of hearings on the impact areas and on cross-cutting issues organised for the Panel to facilitate its assessment of the overall work and achievements in the various areas. A delegation of 6-15 Panel experts, one of whom was appointed rapporteur, attended each thematic hearing. Their draft key observations for each relevant evaluation theme for the Panel were discussed and integrated into the final report.

Due to the restrictions imposed by the COVID-19 pandemic regarding travel and access to JRC sites, the hearings were held virtually. This constituted a limitation on the Panel's ability to complement its formal discussions with more

[4] Staff Working Document SWD 2021_305_en

informal meetings with JRC staff and with visits to the sites and their laboratories.

This limitation was mitigated by virtual tours and by meetings on site with JRC staff during the final two Panel meetings for drafting the report. The two meetings were held in Ispra and Geel, following the easing of travel and access restrictions, and allowed to visit a limited number of laboratories. They also exposed the Panel to the reality of the geographical spread of the JRC.

Two meetings with the JRC top management and with the Ad hoc Group of the JRC's Board of Governors on 'Organisational Transformation' were held at the end of the fact-finding part of the evaluation process. They served as a check point for preliminary findings and to hear an update on current developments at the JRC.

To achieve a more comprehensive view of the JRC's performance, the Panel made a particular point of interviewing, in closed sessions, key stakeholders of the JRC in the cabinets of Commissioners, in the other departments of the European Commission, in the European Parliament, and in the JRC Board of Governors (list in Annex 4).

The Panel brought to this evaluation its experience with having evaluated other organisations and programmes. There are **comparators** for the JRC in terms of mission and scientific basis, but this is limited by the institutional context, size and scope of activities. In particular, benchmarking is less easily achievable when evaluating the impact on policymaking and society. While several other research funding programmes and organisations are using case studies and have developed an impact scoring methodology for assessing the importance of a given impact case, the criteria and processes are different. The use of a coherent narrative, quantified criteria, feedback from policy DGs and an external expert panel by the JRC for its impact case studies is a good step in the direction of enhanced robustness and comparability of such an approach.

Previous evaluations (*ex post* and *interim*)

The recommendations of the *ex post* evaluations of the JRC in 2007-2013 and the *interim* evaluation for 2014-2017, provided good reference points for the Panel's work. In particular:

- they helped the panel to focus on strategic recommendations;
- they provided the opportunity to renew recommendations from these previous evaluations, should they still be found to be valid.

The Panel's assessments of specific follow-up actions are incorporated into part 2.

Part 2 – Evaluation of the JRC's activities

In line with its mandate, and the overall programme evaluation criteria, the Panel has assessed the JRC's activities for their relevance, coherence, EU added value, effectiveness and efficiency.

Due to the Horizon 2020 framework programme and the Euratom research and training programme having different legal bases, the findings are discussed in two separate chapters, providing thematic observations and recommendations for each programme part. However, the JRC is one organisation, and the Panel considered it important to highlight cross-cutting observations and provide recommendations applicable to the JRC as a whole, to give the JRC pointers for future development. All recommendations are listed in Annex 1.

In its work, the panel took into account the recommendations of the previous *ex post* and *interim* evaluations, and the follow-up that the JRC has given to them.

The Panel commends the JRC for making strong efforts to implement the recommendations of previous external evaluations. These efforts have already been bearing fruit and the Panel looks forward to the JRC continuing the good practice of reporting back on the progress made in implementing the recommendations.

Among the various recommendations addressed by the JRC, the JRC introduced innovative instruments to overcome the challenges of research and disciplinary silos, such as knowledge and competence centers; it has also introduced mechanisms to encourage more foresight/blue sky research, although capacity challenges constrain further progress in this area; and finally, the JRC has increased the role of social sciences and humanities in its work, although further improvement is needed. Gender balance has improved in middle management positions, although further efforts are needed at all levels of the organisation.

Chapter 1. Cross-cutting observations and recommendations

Relevance

The Panel found **clear links between policy priorities and the JRC's programming, results and impact**. The JRC has made important contributions to key policy goals, such as the Energy Union, including the energy and climate targets 2020 and 2030, the economic and monetary union, the digital agenda, the further development of the common agricultural policy, and regional development.

The JRC has also contributed significantly to the Commission's working methods for policymaking, the better regulation agenda, and to policy options for funding programmes under the multi-annual financial framework 2021-2027, along with the long-term cross-cutting support to standardisation and measurements and testing. New instruments such as knowledge and competence centres have been established to provide more holistic science-based solutions, and the foresight capacity has been strengthened.

The JRC reacted well to **new policy needs, societal challenges and technological developments**. The Panel saw evidence of agility in developing new programmes on migration and demography, in incorporating cross-cutting concepts such as resilience and the SDGs and promoting them within the Commission. The JRC also presented several examples of assessing the impact of new technologies and building laboratory infrastructure for testing, such as for cybersecurity, artificial intelligence, blockchain, and smart grids. Along with already existing risk alert and response mandates for forest fires, drought and floods, the JRC was able to quickly take up work at many fronts to help the EU respond to the COVID-19 pandemic, although more progress can still be made on providing holistic responses to such crises.

At the same time, activities have been stopped or transferred to other actors because of changing political needs or their operational nature; during 2014-2020, such activities comprised work on transport safety, shale gas, food safety (several EURLs), and the GMO coexistence bureau. The Panel stresses the importance of maintaining data and information from such activities which may be useful for other activities and drawing lessons learnt.

The Panel concludes that the JRC appropriately responded to policymakers' needs.

Prioritise work streams. The Panel noted the **broad range of the JRC's direct actions**. While there may be a certain need for this, given the JRC's mandate to serve the European Commission's policymaking, not all activities seem to be of equally high policy and societal relevance. There is some room for better focussing the resources on activities with the highest impact, where the JRC has or can reach a critical mass and is uniquely positioned to provide the needed evidence. In some cases, the Panel felt that there was insufficient justification for the JRC's intervention based on criteria such as market failure, public interest or utility, or the need for a Commission-funded research and knowledge body to act as opposed to alternative solution providers.

The Panel also noted that many activities were carried out without being sufficiently integrated between different units in the JRC, often resulting in a fragmented approach to solving important challenges. The Panel did not see, in the period concerned, sufficiently structured and integrated

approaches to coordinate between areas of activities, anticipate research needs, collect requests from other Directorates-General (DG), establish priorities based on a coordinated assessment, select activities accordingly and decide which activities to phase out or hand over to third parties.

Several stakeholders were unsure about what JRC can and cannot do, and the lack of priority setting may be a contributing factor. It is therefore important to communicate a clear business model with priorities, competences and capabilities, and to ensure that the JRC is involved in the priority setting among policy DGs at an early stage.

The JRC should be involved at an early stage in the priority setting among policy DGs and establish a centralised process for ensuring that the work programme reflects these priorities and the breadth of knowledge needed to support the priorities. This process should also incentivise policy DGs and the JRC to break silos and integrate suitable workstreams as appropriate.

Anticipate crises. The evaluation took place in a very particular context of two concurrent crises: the Covid-19 pandemic, which started in early 2020, and the war in Ukraine which started in early 2022, even if only the former (and only its first year) is covered by the current evaluation period. The Panel heard a specific presentation on the JRC's reaction to the COVID-19 pandemic and received an impact case study dedicated to this matter. While the JRC responded quickly, using many scientific disciplines, the response to this crisis, and also to previous ones, needs to be more holistic. The EU could strongly benefit from JRC's unique scope of scientific activities and cross-European perspective in anticipating further, or cascading consequences of, crises, such as the economic or financial implications, or opportunities to accelerate the implementation of policy priorities (e.g., the green transition). The JRC is uniquely positioned to alert the policymakers in the Commission and help them take action.

The JRC's response to the COVID-19 pandemic

The JRC established a task force encompassing competences based in different directorates when the scope of the pandemic began to emerge, identified policy needs in close interaction with policymakers, established priorities and action plans and deprioritised other work. It delivered timely support to both resilience (short term crisis management) and recovery, such as the 'Re-open EU' platform for informing citizens of applicable rules and restrictions in the EU Member States, economic and epidemiological modelling of options for recovery, a reference material for validating tests for COVID-19. The JRC also cooperated well with other actors with specific mandates, such as the European Centre for Disease Control. When the crisis was effectively contained, the JRC mainstreamed the relevant research in its work programme.

The JRC should build capacities and tools to prepare for, and respond to, future shocks. To this end, the JRC should i.a. invest in data collection and maintenance regarding past and future shocks.

Attention should be paid to ensure that the anticipation and response mechanisms are designed to be agile and interdisciplinary to cover a variety of potential shocks, and to support the European Commission in taking advantage of the opportunities which such shocks provide for accelerating the implementation of political priorities. Lessons learnt should be drawn and used to improve crisis preparedness and response.

Effectiveness

The JRC has provided effective support to policymaking in the assessed period. This has been evidenced by the presentations and the documentation the JRC has provided, including 50

dedicated **case studies** on impact of specific activities. The case studies in particular measure impact against defined criteria such as significance, geographical and stakeholder reach along four dimensions (policymaking, public debate, scientific debate and societal impact). This approach, including feedback collected from partner DGs and stakeholders, and the evaluation of case studies by Panels of independent experts, has delivered valuable information to the Panel in its assessment.

The Panel encourages the JRC to pursue the case study approach, including peer reviews, for internal learning and evaluation purposes.

The JRC produces research of internationally recognised scientific quality. In terms of **scientific impact indicators**[5], it ranks well among its comparators which include many leading academic institutions, research and technology organisations, and organisations whose mission is similar at least in part to that of the JRC, such as the International Institute for Applied Systems Analysis (IIASA). The JRC has become an indispensable source of key knowledge and data in several areas, such as in robust and reliable greenhouse gas emissions data. A high scientific reputation lends credibility to the evidence in the Commission's policymaking, and the Panel encourages the JRC to continue to publish its work in high impact journals.

The **publication rate** is understandably lower than that of some of the more academic institutions; however, in addition to peer-reviewed scholarly publications, the JRC produces a wide range of policy-relevant studies and outputs, such as standards, reference materials, technical systems, and guidance for policy implementation. In some areas, the JRC could look for further opportunities for scientific publications (e.g. in the work on the economic and monetary union).

The Panel notes the limitations of quantitative proxies, such as bibliometric indicators, for measuring impact and performance, as amply discussed in the (scientific) literature and current initiatives[6]. It stresses the importance of quantitative and qualitative assessments, in particular as regards evidence for science to policy impact. For example, statistics on downloads of publications, such as guidance documents, should be complemented with feedback from stakeholders on their actual use, where feasible.

The JRC should review the indicators for measuring impact, taking into consideration current Commission initiatives on reforming research assessment methodologies.

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.

A pertinent question is how JRC can further **improve its effectiveness**. The Panel has noted a number of potential avenues.

Develop more holistic and broad multi- and inter-disciplinary solutions for policy priorities. The last *ex post* evaluation called for tackling a perceived silo mentality, stimulating cooperation and inter-disciplinarity. The Panel acknowledges the JRC's efforts in this respect, such as the creation of **knowledge centres** or the currently ongoing initiative to structure the work programme in thematic portfolios. However, the Panel did not see clear criteria for when to set up knowledge and competence centres. Attention should also be paid to empowering the respective leader(s) with the appropriate authority and resources to ensure the delivery of the agreed work plans.

The Panel also observed several good examples of cooperation across directorates and disciplines such as on the resilience dashboards, on climate adaptation and mitigation, on the COVID-19 pandemic, and on artificial intelligence. However, it also noted several missed opportunities to

[5] Starting in 2018, the JRC carried out a bibliometric analysis of its research every two years, covering a five-year period, using Elsevier's Scopus databases. These studies were provided to the Panel.

[6] European Commission, Directorate-General for Research and Innovation, Towards a reform of the research assessment system: scoping report, Publications Office, 2021, https://data.europa.eu/doi/10.2777/707440

make use of the existing knowledge and competences to provide **holistic, broad multi- and inter-disciplinary solutions** for policy priorities, such as the twin transitions. In several cases, different research groups were aware of complementary research in other groups with little or no interaction, and no apparent intent to develop a more integrated product or mirror a broader range of applicable knowledge. In other cases, this seems to have been caused by a lack of communication (who does and can do what), entrenched ways of working and relationships with a given policy DG. The Panel recognises that this is not a one-sided issue, but one of both demand and response, and one of appropriate setting of incentives.

The JRC's institutional setting, its mission, and its broad portfolio of knowledge and competences put it in a unique position to help overcome **policy silos**. The JRC's effectiveness in this endeavour can be promoted through enhanced cooperation and interdisciplinary ways of working. The Panel reflected further on means and incentives for improved working methods. The JRC should work with policy DG to ensure that policy needs for evidence (research) are framed in a holistic way in relation to a broad disciplinary range of applicable knowledge. Indeed, impact assessments of policy initiatives should, according to the better regulation guidelines, consider policy options from multiple perspectives. A stronger focus on providing holistic answers to impact assessments, rather than isolated even if useful contributions, would also make the JRC more central to the policymaking process and promote integration of, and synergies between, tools (e.g., models) and methods. Shared scientific interest (for impact assessments) is a powerful motivator; the existing flagship reports and upcoming cross-cutting portfolios as top-down mechanism in the work programme could increase integration through cooperation by design rather than assembly of different strands of separate work, either *ex ante* or *ex post*, and the relevance of the JRC's work.

Finally, the JRC may draw upon experience in other organisations with silo breaking and with developing cooperation, perhaps in the frame of a expert advisory group.

Advance the integration of social sciences in JRC's research. The **social sciences** are a particular case in point for inter- and multi-disciplinary approaches and attention to the social dimension. Throughout all evaluation themes, the Panel noticed that progress had been made since the recommendation of the last *ex post* evaluation: for example, behavioural aspects are included in the analysis of energy efficiency, fiscal policy analysis includes distributional effects. However, further incorporation of social sciences, including political sciences focusing on institutional aspects, would allow the JRC to increase its usefulness and impact, for example in socio-economic impact assessments on the energy and climate policies. This was also expressed as a need by several stakeholders. It would be useful to take a more strategic approach to the role of social sciences in the JRC's portfolio of competences and activities, to take stock of the existing competences, to identify the most important gaps, and to develop a plan to overcome these gaps, including by identifying key partners for cooperation.

A principal object of study in social sciences is institutions, i.e. structures and rules that organise, drive and constrain human behaviour, both formal (law, regulation, organisations) and informal (practices, norms). Because of their attributes – persistency, continuity and legitimacy – and their ability to influence the required social, economic and political change, institutions play a key role in the creation and implementation of public policies. This is reflected by two goals within the SDG framework: SDG16 on stronger institutions and SDG17 on partnership for development. However, the coverage by the JRC programme of those goals, and therefore of institutions in general, is limited. This is despite EU priorities like resilience or strategic autonomy calling for the institutional approach, or the institutional role of the European Commission or the Member States' governments in the EU policy ecosystem. The JRC should extend its activities under the different impact areas to cover SDG16 and SDG17 while taking an active role in supporting the Commission's efforts towards SDGs. To this end, the whole-of-government approach to SDGs is necessary but insufficient. A whole-of-society approach is needed, by which the JRC contributes to the knowledge on the different organisational

and other possibilities of citizens, businesses, government and other societal, economic and political actors, to act on SDGs.

The JRC should use more holistic approaches in designing its work programme and response to policy needs, and develop, as part of its business model, a strategic plan for integrating social sciences.

This plan should include the recruitment of experienced social scientists with broad competences and networks and/or the setting up of a pool of experts the JRC could tap into to enhance its capacity for addressing social aspects in its policy support.

Become more proactive in policy support. A more **proactive approach**, supported by foresight, could make the JRC more effective in helping to shape the policy agenda and make the Commissions' policy work more future proof. A similar observation has been made by the Panel for the *ex post* evaluation of the JRC in FP7, which formulated a recommendation in this regard. The current Panel has seen examples of the JRC proactively stimulating the policy agenda (e.g., implications of novel digital technologies, threats to soils), but this should become more of a standard practice. Beyond working methods, this could be enhanced by the development of thematic strategies.

Similarly, there has been progress in **foresight** activities, starting with ad hoc foresight studies co-designed with policy DGs in the JRC's policy lab, to the JRC's role as co-lead for the Commission's Annual Strategic Foresight Report. However, foresight should be embedded across the JRC in its activities, as foreseen in the JRC Strategy 2030, as part of a stronger culture of anticipation. The Panel believes that this deserves a higher priority. It requires a strategic approach and a strong leadership and governance to identify where foresight would be most useful, to avoid duplications and make best use of resources. To be able to adjust priorities in the light of foresight outcomes, there should be sufficient agility in the planning of the work programme, for example by not overcommitting on deliverables requested by policy DGs.

The JRC should give anticipation a high priority, as foreseen in the JRC Strategy 2030, allocate sufficient resources and set up a governance structure to optimise the efforts.

Develop a data strategy. The Panel noted a large amount of **data** being collected across the different impact areas, and various information systems (e.g. databases, platforms, and services) offered by the JRC based on such data. However, the JRC decisions to invest in new data collection or information systems should be strategic, given its limited resources, broad mandate and unfulfilled needs. In particular, a JRC-wide strategy to drive the collection, integration and utilisation of data is needed, supported by data governance capabilities to break data silos, to guarantee data quality, and to ensure regulatory compliance.

Furthermore, such data collections and information systems could be better exploited and made more usable for their target audience, e.g. citizens, policymakers or experts. Several are quite comprehensive, but this comes at a cost of focus and clear policy messages; they have little analysis or insights that can be drawn from them and thus remain solely for the experts and largely inaccessible and of limited use to policymakers. Other products monopolise access to the underlying data and thus limit the exploitation potential of such data. Instead, the JRC could make available application programming interfaces (APIs) for third-party software to connect programmatically to JRC data collections and information systems, build communities of practice around them, and engage academics to use them in education and research.

As AI-based applications and data-driven analyses are expected to become more relevant to policymaking in the future, the Panel also identified the need for a strategy to decide when to collect new data or use existing data for such analyses. The Panel also felt that the databases were not sufficiently used for anticipation rather than for impact assessments, evaluations, or modelling with a fixed-time horizon. Likewise, the Panel observed insufficient use of social media and other qualitative data to conduct in-depth policy investigations and calls on the JRC to develop capacity to gather, process and analyse

such data. It also calls on the JRC to build capacity for connecting and combining datasets (linked data and data mashups), e.g. combining Earth observation (EO) datasets to build new EO products and generate new insights.

In the Panel's view, the above issues should be addressed through a data strategy, which the Panel understands the JRC has recently adopted (2022), and through building data governance capabilities. Attention should here be paid also to the different requirements and transparency needs for qualitative data that may differ from those for quantitative data.

The JRC should develop and implement an organisation-wide strategy to drive the collection, integration, utilisation and storage of data, to ensure data quality and regulatory compliance and build data governance capabilities to break data silos.

Develop a communication strategy. From its discussion with staff and the stakeholders in the policy DGs, and review of public web sites of the JRC, the Panel felt that there was an opportunity for improving **communication** at three levels:

- Internally within the JRC, between different research groups. Enhanced communication on who does what, on what are the existing competences and resources, could enhance cooperation and integration, avoid duplications, and help to identify opportunities for new scientific approaches.
- With policymakers within the Commission. Several stakeholders expressed a lack of understanding of what the JRC (and science in general) can or cannot provide in terms of evidence for policy making. This is not limited to those who do not have a long and close working relation with the JRC. Clearly, this requires a targeted approach, since the needs of policymakers depend on their role and position. The JRC has recently started round tables involving several policy DGs in the frame of its priority setting for the work programme. These events are a good opportunity for improved communication at senior management level, and should be mirrored by close interactions at middle management level.
- With stakeholders outside the Commission. The Panel felt that there is room for making the JRC better known, emphasising its independence as well as its impacts. The Panel acknowledges the increasing use of social media for interacting with stakeholders and for making JRC results more widely known, as reflected in the increasing response in those media. In the communication with stakeholders, attention should be paid to attractive and easily understandable presentation of impacts linked to current high-profile events. The enhanced user-friendliness of public databases and platforms would also increase the public awareness of the JRC.

The JRC should develop a communication strategy to enhance its communication at different levels, customising it to different target groups, and using the most suitable channels (digital or traditional) to reach to such groups.

Improve the diversity of staff. The Panel noted a lack of diversity, in particular **gender balance** and a **skewed age structure of staff** in JRC management positions, but also at the level of officials in general. There are certainly historical reasons for this, and the previous *ex post* evaluation recommended a recruitment policy to tackle gender balance and diversity in particular at senior and middle management levels. Talent management programmes established since 2016 are positive signs of a proactive approach, and recruitment efforts to address these imbalances have been ongoing throughout Horizon 2020. However, these actions should be complemented with a more proactive search strategy outside the organisation. The scientific development programme could also be used to support this effort.

The JRC should implement a proactive talent acquisition approach at all levels of seniority, with the aim of establishing a more diverse workforce, in particular

with regards to gender balance. This applies to external recruitment but also to suitable internal development programmes to incentivise and motivate potential candidates.

Efficiency

The JRC provided evidence of shifts in **staff allocation** during 2014-2017 to:

- socio-economic research, particularly on pressing issues such as demography and migration;
- research on resilience and fairness-related issues resulting in a better balance with issues related to competitiveness;
- support to the Commission working methods (better regulation), the European Semester and the multi-annual financial framework, under the responsibility of central services (DG BUDG, SG);

while resources allocated to environment, health and food safety were reduced.

According to the JRC, resource re-allocation was accomplished by reattributing positions of staff leaving and closing of some activities based on criteria such as political priority, availability of other actors able to take over, or operational maturity.

The Panel considers that the areas strengthened are broadly in line with **political priorities** and the ambition of the JRC to become more central to policymaking. Nevertheless, some stakeholders voiced concern about the reductions affecting the Euratom research and training programme and the green transition, including environment. In its work, the Panel noted some areas with very high utility and policy-impact, but with relatively lower resources compared with other areas in the same evaluation theme. The recommendation on social sciences is relevant also in this context.

The Panel notes that the JRC does not have clear **indicators for measuring its efficiency**. Despite the difficulty of measuring efficiency in a research context, there have been attempts to do so in response to the last *interim* evaluation of the Euratom research and training programme, asking the JRC provide evidence for its cost-effectiveness. The JRC compared the effort (resources) and output in its participation in select indirect actions with those of consortium partners. As pointed out by the JRC itself, such a comparison is not easily interpreted, and requires highly specific knowledge of the work involved. Besides such specific assessments, the JRC's impact case studies provide useful information on the resources used to generate the impacts, and could in the future be used for an expert assessment of efficiency and for benchmarking.

Nevertheless, 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. The incremental approach to emerging technology research, from awareness-raising and standardisation, through experimental and design research, to capacity building, knowledge sharing and institutionalisation, is also considered by the Panel to be efficient. The implementation of the recommendations on silo-breaking and prioritisation can further add to efficiency.

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

Coherence

The Panel noted a high degree of **fragmentation of activities** in some cases within impact areas and programmes, but also between the nuclear and non-nuclear activities.

This may be due partially to the way in which the activities were grouped under the impact areas, and presented to the panel. The approach was decided on by the Commission for the *ex post* evaluation of the research framework programme, in order to provide a baseline for the evaluation of Horizon Europe.

To achieve conceptually and programmatically **greater coherence** within and across different impact areas, the SDGs, which provide a set of overarching policy goals, could be used. The SDGs can cover transformational and incremental aspects of the sustainability transition, and include modelling such transitions, evaluating

alternative transition paths, and tracking progress along such paths. The JRC programme covers virtually all SDGs except SDG16 on stronger institutions and SDG17 on partnership for development, and a scientific coordination for the SDGs across the JRC has already been set up.

As regards the coherence between direct and indirect actions, according to the JRC, its **participation in indirect actions** complements its direct actions and the material presented to the Panel did not differentiate between the two. At a more programmatic level, the Panel notes that the JRC is included in the governance structure of Horizon Europe for the strategic planning and programming and for the Euratom research and training programme where this coordination (and with Member States) also happens at the level of individual work programmes. The coherence between direct and indirect actions could be an attention point for the upcoming *interim* evaluations.

The JRC's **open access policy** promotes the coherence between direct and indirect actions, but also with national programmes. This policy covers publications, data and research infrastructure. An open access programme to research infrastructure has been developed, with separate modalities for industry and for academia, and is gradually being extended to further infrastructures. The Panel commends the JRC on the progress made, with some specific observations on the user-friendliness of public data sets and information systems, as noted above, and encourages the JRC to further develop this programme.

EU added value

The Panel found a good awareness and use of what are, in its view, the JRC's unique strengths:

- its independence from private and national interests, in association with its institutional setting within the EC, and its broad scientific foundation enable the JRC to convene different stakeholders and DGs;
- its research facilities, several of which are unique, particularly when combined with open access and/or training;
- its ability to provide continuity where actors in the market cannot, for various reasons;
- its long-term experience in working on implementation of EU policies with stakeholders in the Member States, which have made it an effective, trusted and, in some cases, innovative actor;
- its diverse and dynamically changing staff, representing a broad set of competences and experiences, which facilitates taking an inclusive and EU-wide perspective in its policy support.

However, there were some examples where JRC's added value and role were less clear. These are listed under the analysis of the different impact areas.

> **The Panel encourages the JRC to systematically develop and apply criteria in relation to its unique strengths and policy relevance for deciding whether or not to engage in a particular activity, and for disengaging from it.**

Chapter 2. Analysis and evaluation of impact areas

Innovative Europe

The Panel noted the complex and diverse activities in this impact area, logically organised around five main work strands in support to the EU's regional development and research and innovation policies:

- smart specialisation policy as a support for framing R&I for regional industrial development,
- economic impact of EU policies,
- urban development policy,
- research and development investment trends in corporate business firms,
- technology transfer.

The Panel appreciated the support to policy needs through the **unique data and tools** developed for an (*ex ante* and *ex post*) evaluation of regional development policies. The uniqueness of tools such as RHOMOLO and LUISA allows the JRC to be a strategic partner for EU policymaking. In the same line of reasoning, the support to smart specialisation strategies provided by the JRC is fundamental given the *ex ante* conditionality for regions to get access to structural funds. As has been the case in most Member States, regions have limited capacity in developing their own strategies, and an EU-level intervention with the aim to accompany stakeholders in the design and implementation of smart specialisation strategies is of profound relevance.

In its different interventions, the JRC targets the relevant actors. For example, cities are the natural *loci* of innovation and the main leaders of a national development. Their balanced growth is fundamental for a sustainable socio-economic development and hence support via the urban development strand of work turns out to be rightly placed.

The Panel has particularly appreciated the **effectiveness** of the support to policymaking with a high-level scientific performance, and with a good record of publications, despite the policy-oriented mission of the JRC. The scientific content of the research undertaken is innovative and unique in the panorama of European research centres. In addition to its support to policy design, the JRC is able to play a key role in supporting different stakeholders (from universities to national research centres to local, regional and national governments) with the creation of unique databases and information, playing a key role as data and best practice provider.

Cooperation with scientific stakeholders has been demonstrated to lead to advantages for both JRC and third parties. On the one hand, this stimulates the JRC to keep pace with the scientific knowledge frontier via the organisation of, and participation in, scientific events with third parties; on the other hand, it can provide support to the European Research Area (ERA) through an open access policy to unique knowledge and databases. This policy is vital for JRC's effectiveness, and there is room for its reinforcement. This could be achieved through more visibility by linking JRC's databases with well-known public ones, such as those of Eurostat, and through a centralised JRC data platform, maintaining 'theme platforms' for specific thematic information.

The Panel appreciated the improved **coherence** with respect to the past among much of the five strands of work in terms of themes treated. All activities focus on the design, implementation, reinforcement and relaunch of innovation policies in European regions. There is, however, room for further increasing the coherence of the different activities through more cooperation. As an example, the JRC might want to encourage cooperation between the teams for technology transfer team and for smart specialisation

strategies (S3) for the identification of critical areas of technology adoption where technology transfer intervention could be of help. The linkages with local universities and research centres through S3 would facilitate a long-term adoption of the technologies that goes beyond the period of intervention. A geographical coverage of the scoreboard in industrial innovation and dynamics would be more than welcome. It could be in this case applied to regional development policies.

The Panel has the clear impression that the **added value** of the JRC's activities is high: the analyses, support to implementation and the data collections at European level are of fundamental importance for a framework that allows to compare the situation in one region with that in others. Such a comparison requires harmonisation of data, of methodologies applied, of analyses developed, that can only be done by an independent body at EU level, with the primary goal of a collective benefit. Without this intervention, best practice could not be exchanged, technology transfer would only be based on local experience, S3 could not make use of other experiences, and cooperation could probably only be (if any) activated among regions of the same country.

The panel has identified a the following **opportunities for improvement**.

Enhance the coverage of, and access to, databases. Through increased open access policy for its databases, the JRC would be able to play a crucial role in the ERA. Furthermore, the JRC should invest in the creation of data that at present are not available. The Panel has seen some examples but there is room for more. In this respect, the JRC could have a leading role in estimating regional and urban data from the existing national ones, using its models for generating a series of data with detailed geographical and industrial granularities, which are at present missing.

Moreover, more visibility and integration of already publicly available databases would further enhance their usefulness. This could be achieved through linking the JRC thematic database websites with well-known ones such as those of Eurostat. Moreover, integration among JRC's thematic databases would support the revitalisation of ERA. The databases would benefit from harmonisation of the existing ones in terms of regional geographical coverage, and an audacious strategy to estimate data when they do not exist.

Focus research on transformative opportunities of societal challenges. Overall, it is the Panel's opinion that the JRC's activities in this area would benefit from a less demand-driven approach, in favour of transformative – as opposed to incremental – research, as already pointed out in the *ex post* evaluation of FP7, particularly for the twin transitions. This would apply to the modelling exercises, the creation of databases, the indicators and the conceptual approaches. As an example, the ongoing (2021-2022) extension of the S3 to include sustainability aspects still requires a clearer definition, scope and goals, and, overall, a more original approach, clearly detached from what has been done in the past.

In the field of urban and regional policies, the research would benefit from going beyond the modelling exercises and their application to policy evaluation. For example, the JRC could proactively identify the research needs in this area. The JRC could also develop foresight scenarios on the social impact of the new technological transformations, stressing the socio-economic costs of such transformations, especially in terms of regional and urban inequalities.

Resilient Europe

Current crises such as the COVID-19 pandemic, the war in the Ukraine and supply chain disruptions underline the increasing importance of building a resilient Europe. The JRC's activities targeting resilience are thus of strategic importance, especially with respect to the aim of Europe's strategic autonomy or digital sovereignty.

The activities of the JRC are centred around topics on health and food safety, migration and demography, risk and crisis management, economic and monetary union, fiscal policies, economic governance, targeting, e.g. financial resilience, modelling of tax and social benefits systems and civil security including cybersecurity, border security and transport safety.

The **relevance** and the **added value** of these JRC interventions is demonstrated in many ways, for example by:

- helping to overcome fragmentation of approaches and knowledge, for example in cybersecurity, through the support to the establishment of the European Cybersecurity Competence Centre (ECCC) and the Network of National Competence Centres (NCCC) and contributions to various aspects of the new EU Cybersecurity strategy;
- adding EU-wide knowledge and analyses to the European Semester thus strengthening the basis on which projections and decisions are taken and thus increasing the potential effectiveness of the proposed development strategies at national level;
- aggregating EU-wide knowledge and making it available through the Knowledge Centre on Migration and Demography;
- making the banking system more resilient by modelling the impact of different policy options;
- building the EU-wide early warning systems (through Copernicus);
- helping to protect the consumer and the EU budget with statistical tools for protection against fraud;
- helping member state administrations to develop policy options for their fiscal reforms.

The JRC's interventions are effective and are supported by a broad stakeholder reach across key national and EU institutions and stakeholder associations. In particular, the Panel has appreciated **the effectiveness of** support to policymaking through a high level of scientific performance and through its independence from commercial or national interest.

The panel has identified the following **opportunities for improvement**.

Develop more holistic and broad multi- and inter-disciplinary solutions for policy challenges. Addressing multi-faceted societal challenges such as resilience requires a holistic approach that brings together elements from a broad range of disciplines, intrinsically giving rise to complexity in defining the research questions and requiring a plethora of different competencies.

The JRC has taken some steps in the right direction, for example through the development of the resilience scoreboards. However, better incorporating aspects of the green and the digital transitions into the work on resilience, overcoming fragmentation, introducing more interdisciplinarity and transversal projects and a greater focus on understanding the interdependencies would strengthen the JRC's scientific support to policymaking on resilience. There is a strong need to break silos and increase cooperation within the JRC to make best use of the existing competencies. Cooperation with various stakeholders needs to be fostered to tap into a larger competence pool. For instance, in many of the resilience-relevant areas, a deep understanding of technology is essential to optimally support policymakers. Where expertise is not available in-house, it can be acquired through cooperation.

With the increasing importance of resilience, institutions should indeed work together to develop solutions through open engagement activities with e.g. local administrations and other policy actors in the Member States, interest groups, and citizens organisations. The JRC should better embed social sciences to approach the numerous societal facets required for

building a resilient society, including the role of institutions.

To ensure a holistic approach, the JRC should map the relevant fields and disciplines against the resilience concepts to identify the linkages and research that could feed into defining resilience indicators and dashboards. Such work would add to the coverage of aspects such as the role of institutions, which is a less visible element in the JRC's research agenda and give more comprehensive insights beyond the discipline-rooted issues and general considerations on capacities and vulnerabilities.

Develop a strategic approach to data management. The datasets are an important JRC asset and should be made available to other research organisations in an anonymised way if needed. In addition, data governance strategies to ensure an appropriate data management process should be developed (clarifying what data exists and where), together with an assessment of whether their accuracy is sufficient, in case such data are provided by third parties.

Use existing experiences to apply disruptive technologies in support to policymaking. The JRC is encouraged to increase the use of disruptive technologies (e.g. using AI/machine learning approaches) in its research instead of incremental approaches. Anomaly detection approaches for detecting fraud and minimising false positives could be developed beyond statistical approaches.

Move from monitoring to understanding data and information. The JRC will also need to bring its policy support to the next level beyond providing data for monitoring by providing information and knowledge for understanding, and feeding both the data and the information into foresight processes. The JRC should provide the policymakers with a broad coverage of relevant policy advice, including on more recent emerging topics. As an example of this the JRC could monitor how well the green and digital transitions are progressing in the packages for the European Semester.

Act more strategically and be more proactive in order to enhance impact. Dependencies and trade-offs between various policy priorities and disciplines need to be explicitly identified. For example, resilience aspects of the green transition can hardly be considered without touching on issues of civil (cyber) security. Similarly, the JRC should take a strategic approach to greening the EU financial system and better adaptation of the investments needed for the green and digital transformations to succeed by addressing the risks associated to climate change and the digitalisation of the financial systems. With regards to crisis management, the JRC should take a more proactive role in identifying potential future shocks and helping the Commission to prepare for them.

Lastly, collecting feedback and developing indicators on e.g. the impact of regulations the JRC has helped formulate would allow the JRC to improve the quality of its policy support.

> **The JRC should embed the concept of resilience in all the relevant activities, and develop a more holistic, strategic, and cross-disciplinary approach for assessing and monitoring resilience.**

The digital and industrial transition

This impact area has two different components: digital transition and industrial transition.

The activities on the **digital transition** were designed around three EU policy priorities:

1. trustworthy digital technologies – to build secure, smart and resilient digital infrastructure and capacities taking into account the social, economic and political elements;
2. Digital Europe and Digital Decade – to build the skills, infrastructure, businesses and administration required for the digital single market;
3. geo-political issues – to address the globalisation of threats and the blurring of the traditional boundaries between civil and military and between physical and digital.

The work on the **industrial transition** supported the formulation and implementation of measures to decarbonise energy intensive industries and the adoption of best available techniques for reducing industrial emissions. Furthermore, the JRC contributed to strategic autonomy through its work on dependencies and supply chains for raw materials in priority sectors.

The Panel found that the activities address important societal needs and provide significant **EU added value**; for example, the digital competence framework addresses a gap in digital skills which are a flagship goal of the digital transition; through the quality assurance and collation of user requirements, as well as testing of satellite-based navigation, JRC has a strategic role in promoting space-based services. The JRC's leadership in establishing best available techniques for reducing industrial emissions has taken on renewed importance with respect to the zero pollution goals.

Social sciences appear to be generally well embedded in the work on the digital transition (e.g. digital skills, impacts of digital technologies). On the other hand, the Panel wondered whether the JRC is still needed for the technology assessment of energy-intensive industries, or whether there are other important demand-side issues, such as consumption patterns, that should be addressed instead (see under the green transition).

Programmatically, focusing on building trust in digital systems enhances the efficiency of the digital transformation, working through the national authorities and international partners amplifies the impact of JRC in the EU and globally, and the use of JRC tools and advice by many directorates and units confirms the **efficiency** of the investment. The JRC's **effectiveness** is demonstrated by its approach to the emerging, high-risk technology research (e.g. artificial intelligence and blockchain), from awareness-raising, through testing and standardisation, to capacity building, knowledge sharing and institutionalisation.

The Panel considers that there is good **coherence** in the work on the digital and on the industrial transition. For example, the JRC pursues synergies between the space, defense, and security domains under the strategic autonomy drive. Researching the interrelated issues of data, digital platforms and regulatory instruments, gaps in digital skills vis-à-vis digitalisation in education, non-interoperability between EU public administrations all contribute to the synergy of the EU digital landscape.

The Panel has identified of the following **opportunities for improvement**.

Promote closer collaboration across JRC.

The work on emerging technologies, e.g. AI and blockchain, is not sufficiently known in other JRC units which build their own AI capabilities rather than reuse what exists. This calls for more communication across the JRC, packaging relevant capabilities for possible reuse and building synergies through horizontal portfolios. The latter could bring streams of work together to address interrelated policy issues. Also, the JRC should exploit collaboration between groups with overlapping policy interests and complementary capabilities. The Panel appreciates examples such as Earth observation vs. urban change measurement, Copernicus emergency management vs. risk and crisis management. However, there are some further opportunities such as: 1) data and platform

economy vs. strategic autonomy, 2) data and platform economy vs. trusted digital technology, 3) AI vs. AI applications for demographic forecasting. The first collaboration might monitor changes in the global digital regulation landscape and their impact on the EU and its international standing while the second could facilitate the JRC contributions to implementing the relevant EU policies such as the Digital Services Act, the Digital Markets Act, and the European Data Strategy. Finally, the JRC should promote the use of the space applications infrastructure by other JRC groups, e.g. by the urban development or risk and crisis management groups, for which applications clearly exist.

Build synergies across impact areas. The digital transition is transversal to many policies and instrumental to scaling up their implementation. Hence, the JRC should seek to fully utilise this transition and highlight its interconnection with other transitions, in particular the green one, and other impact areas. However, except the digital-green transition, other twins are absent in the JRC programme; for instance, the emerging technology research has no application domain from the impact area Innovative Europe. To deliver solutions to policy problems, technology (solutions), policy (problems) and new practices (innovation) must be linked. To this end, the JRC should exploit the digital-innovative twin, for instance to study data ownership. Likewise, the green transition requires altering individual choices which can be supported by digital platforms under the digital-green twin. But digital technology also causes adverse environmental impacts such as the computationally-intensive cryptocurrency mining. Thus there is a need for a feedback loop from the green back to the digital transition. Examining these and other twins – such as innovative-resilient or digital-green-innovative - is particularly needed when pursuing an overarching SDGs agenda.

> **The JRC should consider using the digital-green twin transition as an example and build capacity for problem-based multidisciplinary research for other twins.**

Explore new policy frontiers of the digital transition. To address a challenge as fast-moving and comprehensive as the digital transition, it is vital to anticipate opportunities and obstacles, involve the appropriate actors, and act in an agile way.

- Anticipatory and foresight research is particularly important given the rapid technological change and uncertain nature of the resulting impact. The JRC should apply foresight to help connect technology and applications and guide future capacity development toward emerging policy problems, making use of machine learning and other forms of artificial intelligence to develop scenarios. Going beyond the current digital competence framework, which is focussed on currently-needed skills, foresight capabilities should also be applied to identify what skills will be needed by the next generation of the digital natives, making them ready for jobs that will exist in the future. The JRC could look for answers to questions like how should we make automated offices ready for human-machine collaboration and for using machines for previously human-only tasks, and what is the role of institutions in supporting the digitally-vulnerable in the digital-by-default world.
- In its technology for policy research, the JRC should ensure that policy requirements drive technology choices, not the other way round, e.g. when policy requires explainable outcomes, rule-based systems might be preferred over machine learning systems.
- The negative impact of the digital transition also needs special attention. This includes the widespread hidden influence of algorithms on people's and institutions' decisions, endangering the societies' ability to govern themselves, and leading to the calls for - and research on - algorithmic transparency. This also includes, e.g. the speed of self-replicating digital communication, rapidly spreading and becoming viral over digital networks, causing hard to predict shifts in social, economic and political sentiment; reliance on common digital technologies in the environment of hyper-connectivity and

digital inter-dependence, increasing collective vulnerability to digital threats; advancing automation of government processes reducing administrative burden on everybody except the most vulnerable, increasing social exclusion; and digital divide - unequal access to digital technologies and digital competencies and ability to benefit from them - exacerbating existing generational, educational, urban-rural, and other divides.

Lastly, for high-impact reports on changing technology frontiers and their policy applications, the JRC should keep them current, republishing them periodically with new data, analysis, and feedback from the target audience including policymakers.[7]

[7] This suggestion applies also to other impact areas.

The green transition

The JRC presented its contributions to the green transition impact area under six pillars:

1. **environment**: including supporting EU policies on land use and land change, forests, soil, health, air quality, freshwater quality, marine resources, invasive alien species, and biodiversity;
2. **circular economy**: including the establishment of the Bioeconomy Knowledge Centre, life cycle assessment methodologies, supporting sustainable product policies as well as those related to waste management;
3. **sustainable agriculture**: including modelling the impacts of climate change on – and the greenhouse gas emissions from – agriculture, as well as providing scientific support to policies on fisheries and pollinators. This theme also includes the JRC's support on simplifying control measures under the common agricultural policy, fighting against unfair trade practices in farming, and providing forecasts on crop yields.
4. **climate**: including activities on how the JRC supports EU policies on addressing, mitigating, monitoring and adapting to the effects of climate change.
5. **energy**: including several activities in which the JRC is contributing to the decarbonisation of energy supply as well as supporting the resilience, security, integration and digitalisation of energy systems and markets.
6. **transport**: including supporting policies on green, smart and safe mobility.

On the basis of the evidence provided and the stakeholder consultation, the Panel considers that the JRC is clearly at the frontier of policy relevant research in many areas related to the green transition, including climate change. The publications of the relevant groups are in high impact outlets and many of them are influential in setting agendas.

The green transition is a response to the urgent need to update and extend previous policies and targets on climate, energy efficiency, emissions and other relevant topics, and to develop a more holistic approach by incorporating drivers such as the food chain. Accordingly, the JRC activities present a more coherent picture with respect to the well-established priorities and less so with the newly incorporated drivers. Furthermore, there is some awareness of the need to examine interactions between impact areas such as the twin transitions, for example looking at the energy use of information and communication technology. However, there are unexplored opportunities and trade-offs which the JRC would be well placed to explore, as pointed out in the cross-cutting recommendations.

The relevant key influential international assessments, such as the Intergovernmental Panel on Climate Change (IPCC), as well as UNEP and the Commission, rely heavily on data, knowledge and experts provided by the JRC, such as the EDGAR database, and the JRC experts regularly contribute to these assessments. JRC models and data are the foundation for the EU's position as a global frontrunner in the movement towards a more circular economy and in the use of life-cycle assessment for science-based policy support. The stakeholder consultations have also reaffirmed that, in many of the relevant areas, the JRC is their first choice for science advice , and in fact they would strongly welcome larger capacities in the JRC in this field to be able to rely more on its inputs.

The JRC should also be commended for a significantly improved integration of social sciences and institutional structures (e.g. knowledge and competence centres) to break the silos. By now, many topics tap into the relevant social science basis, even though further strengthening of the **societal, political and in particular institutional level analysis** aspects are needed. This relates, among others, to issues that have already been identified in overarching recommendations and, in this case particularly, to a need for strengthening the capacities for socio-economic impact assessment.

There are additional **opportunities for improvement** and further reflections, from

which we highlight those focusing on the key themes presented and underpinning the cross-cutting recommendations.

Research *foci* within the energy and climate field need to make more progress with recent developments and provide more foresight. Whereas the ongoing research within the JRC on these topics is at a high level, some of the topics themselves represent old priorities and have not been revised with a changing world and scientific landscape and can be considered as narrow for today's climate and energy research priorities. For example, the JRC still mostly concentrates on technologies and the energy supply side whereas the science has shown that behavioural change, lifestyles, consumption patterns, or structural changes, among others, are equally important.

As the recent IPCC report shows, demand-side changes are crucial also to reaching supply side goals. Yet there is limited attention to demand and more systemic changes in the overall JRC research portfolio. For example, while electric mobility will play an important role in addressing climate change concerns, further structural changes, such as shared mobility or mobility as a service or more structural enabling of active mobility are needed to solve also other mobility related challenges such as urban congestion and resource use. Furthermore, energy research in the JRC is mostly focused on the climate aspects, whereas the EU also faces a very large number of further challenges related to energy and environment, including energy (fuel) poverty, energy-related air and other pollution, biodiversity loss as well as energy security and sovereignty. The external assessment of the case studies also indicated uneven impact on stakeholder decisions of the research conducted by different research groups within the green transition impact area.

> **The JRC should rethink its research foci in energy, climate and transport, and shift more attention to the demand side, systemic and institutional solutions, perhaps even to consumption and lifestyles, as opposed to just technology and the supply side. It should also address energy challenges in a broader context than just climate change, for example energy poverty and biodiversity loss.**

Take a strong role in developing an alternative metric to GDP. It has been clear for decades that the GDP is a poor metric of both economic progress and well-being. Still relying heavily on GDP as a primary yardstick of progress, the EU has been not only missing many opportunities to reach its multiple goals, but it is occasionally compromising its own interests and goals. The JRC has strong competences in developing indicators and would be well-placed to support the ongoing Commission initiatives on developing an alternative metric to the GDP. There are many efforts to develop such a metric, but the EU needs one that reflects its values and priorities. The JRC should not only take a strong role in developing this, but also actively promote its use within the Commission as a key metric to measure progress.

An independently operated, transparent, open source and inclusive energy model for the EU is needed. Such a model has been long overdue, and the JRC's efforts towards creating the POTEnCIA need to be strongly applauded. However, it has still not entered the key policymaking processes, and is not fully functional even for the scientific community, which is a major loss for Europe. The Panel wants to specifically point to the pressing need of stakeholders for an operational and useable POTEnCIA model. Although the Panel understood the strong challenges that have been preventing the JRC from completing this model fully, it would be important to raise these challenges to a higher level and find solutions perhaps at the highest levels for the whole EU research and policymaking community to be able to benefit from it.

Chapter 3. Analysis and evaluation of nuclear safety and security

The JRC performs research and supports the implementation of nuclear safety and security regulation under the Euratom research and training programmes.

These programmes follow from the Treaty establishing the European Atomic Energy Community (EAEC or Euratom)[8] in 1958, which made the Commission responsible for promoting and facilitating nuclear research in the Member States (indirect actions) and for the implementation of Community research and training programmes (direct actions). The Euratom-funded work represents roughly 25% of JRC's resources in terms of staff with a budget of EUR 855 million for the seven-year period.

In 2014-2020, its work programmes were built around five specific objectives set out in the Euratom research and training programme:

- to improve nuclear safety including: nuclear reactor and fuel safety, waste management, decommissioning, and emergency preparedness;
- to improve nuclear security including: nuclear safeguards, non-proliferation, combating illicit trafficking, and nuclear forensics;
- to increase excellence in the nuclear science base for standardisation;
- to foster knowledge management, education and training;
- to support the policy of the Union on nuclear safety and security.

The activities presented to the Panel covered the areas of nuclear safety and security, including emergency preparedness and response, safeguards, and non-energy application of radionuclides, as well as the cross-cutting activities referred to above.

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 Panel finds that, by building and maintaining competencies in nuclear security, safety and safeguards, the JRC activities have **served both the EU and Member State policymaking**.

The JRC has contributed to the development of tools and methods, helping to achieve high safety standards for nuclear installations and fuel cycles relevant to the EU. It has supported Euratom and international safeguards by developing innovative new and enhanced methods and technology to prevent, detect and respond to nuclear and radioactive incidents. Research on fundamental properties and behaviour of actinides, structural and nuclear materials such as studies on ageing of reactor systems, structures and components, or long-term behaviour of nuclear waste and standards supports the longer term goals of EU policies. Training and education action were implemented through comprehensive programmes building capacities in the Member States, summer schools and short courses, through research grants to students and open access schemes.

[8] The Euratom Treaty is a legally distinct entity from the EU, although it has the same membership and is governed by the EU Institutions.

The JRC has also developed non-energy applications such new cancer therapies based on alpha irradiation and power sources for space exploration.

The legal basis sets out that the JRC must foster its expertise and excellence to provide independent scientific and technical evidence. The Panel felt that the JRC has delivered on this and the **quality of the work** is excellent. Besides, the JRC's scientific record of publication is good and the goal to publish the scientific work openly is valued.

There are a number of **drivers** to which the JRC should continue to respond. Today, the EU is facing major challenges such as climate change and the need to secure the energy supply and energy independence. These may impact the role of nuclear power in the energy mix of some Member States with consequences on the demand for nuclear expertise in Europe. At the same time, there is a need to address issues related to new technologies such as the small modular reactors (SMR), to waste management and decommissioning of ageing power plants, and non-energy applications.

For the deployment of **SMR technologies** the impacts on regulations and the applications of safety, security and safeguards need to be addressed by the JRC, in the next strategy and its action plans. This should address both the policymaking needs (especially to shorten the licensing process in those Member States in which the energy mix includes nuclear energy) and national energy strategy needs (e.g. to replace the existing coal power plants and to ensure security of energy supply) with relevant technical data and reports including the assessment of safety, security and safeguards aspects. The need for standardisation for SMRs would be a good opportunity for the JRC to consolidate its role vis a vis policy and to promote cooperation across the JRC.

> **The JRC should study regulatory aspects as well the safety, security and safeguards of small modular reactors.**

A number of nuclear power units in the EU are being decommissioned, either due to the ageing of the nuclear power plants (NPP) dating back to the early 1970s or due to national political decisions. These activities call for new types of technologies, safety measures and waste management processes and solutions. The EU-funded **decommissioning** activities of Jaslovské Bohunice (in Slovakia), Ignalina (in Lithuania) and Kozloduy (in Bulgaria) units and the JRC facilities are ongoing. While these activities are outside the scope of the present evaluation, the data sharing organised by the JRC is a good example of benefits obtained from its expertise and tools. However, these activities should cover more examples of national decommissioning experiences. All NPPs will be decommissioned at some point, and this is not considered yet in the JRC's programmes and strategies apart from the knowledge dissemination component of the operational decommissioning and waste management programme.

The **long-term operation of NPPs** introduces new needs for ageing management and safety analyses as well as verified tools for these operations. Similarly, the fuel cycle, starting with the new fuel types e.g., mixed oxide and innovative UO_2, requires data and analyses for the safety case analyses and verification of the relevant tools. This type of capacities exist at the JRC, especially the sharing of tools and data, developed through the Euratom programmes, serve the needs of the Member States. However, new needs are emerging and should be addressed.

In addition, **cyber security** issues have become more common and this remains a future challenge for which international collaboration and benchmarking are necessary. Robust solutions need to be developed for safeguards.

The JRC's broad nuclear research and policy support programme has delivered tailored solutions in response to policy needs. In the rapidly changing political context, however, the JRC needs to develop and adopt new technical solutions. This is important for ensuring implementation of **safeguards** and international agreements but also for providing assessments and studies and capacity building.

A number of the above 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

nuclear research programmes in the individual EU Member States as well as internationally, e.g. with the US and Japan. The JRC also participates in the EU research cooperation through EU funded projects (the indirect actions) and participates in innovative research topics such as SMR technologies and the safety of accident tolerant fuels. There is strong participation in international nuclear safety and infrastructure programmes, e.g. materials testing in the Jules Horowitz Reactor, or of the IAEA and OECD/NEA In the area of nuclear waste management, participation in the IGDTP co-operation, in indirect actions and individual research cooperations are important fora and means to advance knowledge. As the Euratom Implementing Agent for the Generation IV International Forum (GIF), the JRC coordinates the Community contribution to GIF. These collaborations reinforced the EU's scientific and technical expertise and provided synergies of research efforts in solving common challenges (such as materials, coolant technology, reference nuclear data, modelling and simulation, remote handling, waste management, radiation protection) and helped avoid duplication of nuclear research and development in the EU, and globally.

However, the reduction in resources 2021-2027 will require more prioritisation in collaboration in the future.

The **open access programme** to JRC's research infrastructure now includes several unique nuclear facilities. The aim is to strengthen, through open calls, the cooperation with European universities and research institutes by offering possibilities to work at selected JRC facilities, including the many unique nuclear facilities. Important results have been achieved, yet the Panel sees further opportunities for even greater access to the JRC facilities in particular to enable training of researchers and students from the EU. In addition, there is a need to develop such open access scheme to pilot repositories in Europe, to provide possibilities for testing on-site characterisation and monitoring techniques, which could be coordinated by the JRC.

The JRC has decided to no longer participate in Horizon Europe and Euratom **competitive bidding**. However, the JRC can join the grant agreement as beneficiary requesting zero funding. This decision together with the ongoing and announced budget cuts may lead to less cooperation through indirect actions. This in turn underlines the importance of the open access scheme in contributing to EU and national research programmes. The JRC could also enhance training and education for nuclear energy and non-energy uses and cross-cutting topics. The delivery and impact of such training could be one of the measures of the JRC's effectiveness. The instruments for enhancing training are available, e.g. Euratom research programmes and platforms that have training tasks and could benefit more from the JRC's input.

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.

The Horizon 2020 and the Euratom research and training programmes have separate legal bases and this seems to be reflected in the way the JRC designs its nuclear research and policy support activities.

> **The JRC should integrate social science research in the Euratom activities, in particular as regards risk assessment, crisis preparedness and response, making use of the approaches to be developed for the JRC as a whole.**

There was only little evidence of genuine collaboration between the nuclear research teams and other JRC directorates, and even between the JRC's nuclear research teams. One of the positive examples is the work in CBRN risk mitigation, under the EU CBRN action plan in support to DG HOME, and in external outreach with FPI. In particular, under the EU CBRN Centres of Excellence initiative of the NDICI, which has been operating for the last 10 years, the JRC has brought together colleagues from different directorates in joint expert teams. Developing such interlinkages in other areas, such as resilience, emergency preparedness and response, future energy systems or health applications would make the JRC's policy support

more relevant and unique, and allow making the best use of available resources.

> **The JRC should further embed the concept of resilience and the green and digital transition in the Euratom part of its work programme.**

For instance, the Green Deal circular economy ambitions present a challenge for **nuclear waste management**. Thus, the ways and targets to minimise, treat or recycle the waste need to be studied and solutions for the non-energy use wastes need to be found. Here the JRC, having initiated activities already, could play a role in mapping the needs and solutions, and pooling knowledge from across the EUs. In general, building competencies in nuclear decommissioning, waste management and related safety, safeguards and security topics should be a strong area at the JRC to support Euratom and the Member States with scientific knowledge and data.

Geological nuclear waste repositories are being constructed in Finland, and Sweden and they will soon be approaching the operating phase, requiring new methods and skills for safety analyses and safeguards, and developing data and knowledge sharing among the Member States. In addition, research is ongoing on transmutation of nuclear waste.

> **The JRC should strengthen competencies to support spent nuclear fuel disposal activities and develop strategies to capture and share best practices from EU and national projects with all EU Member States.**

Despite the positive outcomes of the JRC's research programme, it is not particularly well known and visible to wider communities, policymakers, research organisations and academia in the Member States. Therefore, the JRC should invest more in **communication,** integration and in making its studies, high quality scientific assessments for the topical energy questions and non-confidential data and databases more readily available. This would serve the needs of decision-makers and public stakeholders and enhance its representation in the media.

The JRC's **nuclear research infrastructure** is unique in offering special facilities that are not available in the Member States due to the high investment costs and the need for highly skilled employees. This infrastructure is especially important for finding solutions to the challenges of climate change and for the European strategic energy independence. But also the safe use of nuclear energy and the development of innovative technologies or solutions to implement the Green Deal depend on the availability of specialised research infrastructures. Through the JRC's open access schemes, these laboratories are available to researchers in the Member States, who can perform experiments which they would otherwise not be able to do. The JRC facilities are also essential for the development of certain cancer treatments as they are presently the only one in the EU capable of producing the emitters for targeted alpha therapy at the level needed for clinical treatment. It is therefore important that the JRC keeps investing in these facilities, to contribute to the EU's self-sufficiency in nuclear expertise in the long term.

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**. Both the Fukushima accident and the COVID-19 crisis have demonstrated the JRC's adaptability and ability to pool the necessary competencies in support of a EU response. For instance, during the COVID-19 crisis, access to the nuclear installations was limited, impacting the implementation of nuclear safeguards. The JRC then helped developing strategies for virtual surveillance, also turning the challenges into potential/efficient solutions for future uses.

The JRC should develop a capacity for developing scenarios through **foresight,** to prevent decision-making based on non-EU research data and solutions only. Such foresight capacity should be cross-cutting, not only considering narrow technical topics of nuclear energy but the energy field as a whole. This would help to better link Euratom activities to the green transition and work on resilience. Senior-level experts should be available at JRC for these

tasks. This would also support the national nuclear energy strategies of the Member States.

> **The JRC should develop foresight activities for nuclear energy, in support of the green transition and for promoting the resilience of the energy system.**

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.

> **The JRC should maintain a strong research programme for nuclear safeguards and non-proliferation.**

The JRC has also the potential to deliver positive messages about nuclear research, in particular in the context of non-energy applications for medical care and space exploration, or of monitoring of radioactivity in the environment.

The Panel notes the following **opportunities for improvement**:

- The JRC should assess the opportunities and challenges, including cybersecurity, of **digitalisation, artificial intelligence and machine learning** in nuclear security, waste management and in particular safeguards. Concepts, guidelines and practices in safeguards might need to be reviewed in the light of technological changes.
- The objectives and main activities supporting nuclear safety policies need to follow the topical changes in demands of the energy systems. Fast changes in the operating environment are calling for **resilience** for the energy production but also for the supporting activities in nuclear safeguards such as the JRC is supplying.
- The JRC's ability to ensure continuity of European resources is important for nuclear safety and security where issues can arise at domestic level but also from the international grounds and unexpected events. These issues need to be analysed and responded to at a European level to maintain the high nuclear safety standards continuously. A specific case in point is the support to multinational **nuclear waste management** activities under the SAMIRA[9] task with regard to non-energy radioactive waste, an issue which important for all Member States.
- In the same way, the technical challenges have to be overcome to enable Europe to launch and operate **deep space and planetary missions**, especially when the use of solar power generation will be insufficient. According to ESA requirements, a future European power source for space should be based on americium-241 and the role of JRC in the development and production of ceramic fuel will be essential due to its research infrastructure and technical skills.
- As has been pointed out in Chapter 1, the JRC has the potential to provide more holistic support to **EU crisis preparedness and response**, and it should better integrate relevant activities under the Framework Programme and the Euratom programme.
- To ensure the right skills for the future, the JRC should pay attention in particular to better **gender balance** in this area, and be proactive in its recruitment and talent management.
- **Communicating** the value and the services the JRC provides will need to be significantly reinforced to both ensure best use of these resources across the EU and guarantee the continuity of the services and the infrastructure.

[9] SAMIRA Action Plan – the Strategic Agenda for Medical Ionising Radiation Applications. The Plan aims to improve EU coordination, ensure that radiological and nuclear technologies continue to benefit the health of EU citizens, and contribute to the fight against cancer and other diseases. This Action Plan is the first follow-up to Europe's Beating Cancer Plan, adopted by the Commission on 3 February 2022.

The boundary conditions for 2021-2027 call for additional remarks. The JRC has reported on significant budget cuts for the new Euratom research and training programme 2021-2027, with impact on both the infrastructure and the staffing. 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 safety and security of nuclear energy production, waste management and non-energy uses. As the JRC is updating its strategy on nuclear activities, the needs and priorities for the next 10 years should be set out so as to clearly define how and where the budget cuts are realized. The ability to adapt priorities and redeploy resources under the constraints on hiring new staff, expensive infrastructure and maintaining the mandated responsibilities is essential. Increasing cooperation with third parties could provide solutions for dealing with capacity or competence gaps. The five-year budgetary frame and the budget cuts seem to be problematic for the JRC to develop a more forward-looking approach, including the preparation for unknowns such as the Fukushima event. The follow-up to this event through research and the European stress tests across Member States are a good example of a quick response. The ability to respond quickly calls for skilled staff, data and codes to be available for the use of the EU, to which the JRC can contribute.

Part 3 – Concluding remarks

The evidence provided by the JRC, the hearings with scientists and the interviews with stakeholders paint a positive picture of the JRC in terms of scientific standing, impact and focus on policy priorities. The Panel also noted a positive evolution in the JRC since FP7 as regards integration across disciplines, in particular the inclusion of social sciences and through the establishment of knowledge centres. The recommendations aim to make the JRC play its role even better in the running financing period (2021-2027), and are largely focussed on working methods even if there are important remarks on the contents also.

In the Panel's view, an **advisory group of eminent experts** - ideally with experience of working at the science-policy interface - for suitably chosen themes and strategies could be useful for the JRC to further develop along the lines of the recommendations in this report. It could place a particular focus on:

- interdisciplinary approaches and on promoting integration, interlinking the various impact areas and the different knowledge centres;
- moving beyond the areas and methods traditionally used in the JRC;
- bringing in knowledge from outside the JRC to assure a full coverage of relevant knowledge for policy;
- helping to set priorities.

The wide portfolio of the JRC's activities presented a significant challenge for the panels to fully assess and make recommendations for the major activities. Most recently, the FP7 *ex post* evaluation panel suggested to carry out a dedicated evaluation of each theme per funding period, and to establish a scientific advisory board as part of its governance structure. Since then, the JRC has organised two dedicated external evaluations between 2014 and 2020: on production of reference materials in 2016 and on industry relations in 2017. While this approach has advantages such as looking at an entire body of work over a longer time-period, the drawbacks are the effort involved, the lack of continuity and the lack of being able to influence the activities in near real time. Indeed, the evaluation of the reference materials activities recommended to establish an advisory body or mechanism for priority setting, which the JRC has acted upon. The Panel feels that this approach would be useful for other activities too, with members of the group appointed for a fixed term.

The Panel considers that the role and mandate of such a group should be complementary to the established governance structure of the JRC.

> **The JRC should establish a external expert group to advise on strategic development, integration and priority setting of its activities.**

As final remark, the Panel would like to underline the usefulness of the meetings with key stakeholders. Their views stimulated the discussions of the Panel and confirmed many of the findings.

> **The Panel recommends to maintain interviews with stakeholders by the panels in future external evaluations under the framework programmes for research and innovation and the Euratom research and training programmes.**

Abbreviations and definitions

AI	Artificial Intelligence
CBRN	Chemical, Biological, Radioactive, Nuclear
DG	Directorate-General
EDGAR	Emissions Database for Global Atmospheric Research
ENSREG	European Nuclear Safety Regulators Group
EO	Earth observation
ERA	European Research Area
ESA	European Space Agency
EU	European Union
EURL	European Union Reference Laboratory
FP	Framework programme
FP7	Seventh framework programme for research and innovation
FPI	Service for Foreign Policy Instruments (European Commission)
GDP	Gross domestic product
GIF	Generation IV International Forum
GMO	Genetically modified organism
IAEA	International Atomic Energy Agency
ICT	Information and communication technologies
IGDTP	Implementing Geological Disposal of Radioactive Waste Technology Platform
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
ML	Machine learning
NEA	Nuclear Energy Agency of the OECD
NDICI	Neighbourhood, Development and International Cooperation Instrument
NGO	Non-governmental organisation
NPP	Nuclear power plant
OECD	Organisation for Economic Co-operation and Development
POTEnCIA	Policy Oriented Tool for Energy and Climate Change Impact Assessment
SAMIRA	Strategic Agenda for Medical Ionising Radiation Applications
SDG	Sustainable Development Goals
SMR	Small modular reactor
SNETP	Europe's Sustainable Nuclear Energy Technology Platform

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Annex I

Terms of reference for a panel of experts

Ex post evaluation of JRC direct actions in Horizon 2020 and EURATOM (2014-2020)

1.1. Background

This document provides the terms of reference for a panel of experts that will conduct the ex-post evaluation of the direct actions by the Joint Research Centre (JRC) from 2014-2020 under Horizon 202010 and the Framework Programme of the European Atomic Energy Community11 2014-2018 and its extension 2018-2020.

These activities are implemented through bi-yearly work programmes.

The regulations also stipulate that the JRC should "generate additional resources through competitive activities; these include participation to the indirect actions of the framework programmes, third party work and to a lesser extent the exploitation of intellectual property ". In total, the JRC generates an additional income of around 15-20% to the above-mentioned budget, including revenues from dedicated tasks at the specific request of other Commission departments under an administrative arrangement.

As the science and knowledge service of the European Commission, the JRC has the mission to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle. Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

1.2. Legal basis for the evaluation

Both Article 32 of the Regulation concerning Horizon 2020 of the European Community10 and Article 22 of the Euratom Framework Programme11 require an external evaluation by independent experts of the programmes' rationale, implementation and achievements.

Specific inter-institutional and Commission requirements further frame this evaluation. The Commission's Internal Control Principle number 12 commits the Commission to evaluate all the different types of activities it undertakes. It requires that: "*The impact assessment and evaluation of expenditure programmes, legislation and other non-spending activities are performed in accordance with the guiding principles of the Commission's better regulation guidelines, to assess the performance of EU interventions and analyse options and related impacts on new initiatives*".

The process and requirements for evaluation are also stipulated in the Commissions Financial Regulations[12]. In Chapter 7 (Principle of Sound Financial Management and Performance), Article 34 states that "... *Programmes and activities which entail significant spending shall be subject to ex ante and retrospective evaluations, which shall be proportionate to the objectives and expenditure*".

and

"Retrospective evaluations shall assess the performance of the programme or activity, including aspects such as effectiveness, efficiency, coherence, relevance and EU added value. Retrospective evaluations shall be based on the information generated by the monitoring arrangements and indicators established for the action concerned. They shall be undertaken at least once during the term of every multiannual financial framework and where possible in sufficient time for the findings to be taken into account in ex ante evaluations or impact assessments which support the preparation of related programmes and activities."

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10 Regulation (EU) No 1291/2013 of the European Parliament and of the European Council

11 Council Regulations (Euratom) 2014/2013 and 2018/1563

12 Regulation (EU, Euratom) 2018/1046

1.3. Purpose of evaluation

The evaluation serves the following high-level purposes:

- Transparency and accountability: by providing independent feedback to the budgetary and legislatives authorities, Member States and other stakeholders on the performance of the organisation and the use of its budget in Horizon 2020.
- Organisational learning: by examining the follow-up given to previous external evaluations.

The evaluation should also provide a forward look with recommendations for further strengthening the JRC.

The Commission will be informed on the outcome of the evaluation through the Panel's final report and may communicate the report to Council and Parliament, and register it for inclusion in the independent evaluation of the overarching framework programmes.

1.4. Scope

The evaluation addresses all direct actions conducted by the Joint Research Centre in the context of both JRC's part in the Specific Programme of Horizon 2020 and of Euratom 2014-2020. The specific objective of these actions was to provide customer-driven scientific and technical support to the Union policy-making process, complemented by forward-looking activities. The JRC was to contribute to the general objective of Horizon 2020, which is to help implement the Europe 2020 strategy and other priorities, and its priorities Excellent Science, Industrial Leadership and Societal Challenges. Actions under the Euratom programme aimed, in particular, at the continuous improvement of nuclear safety, security and radiation protection, notably to potentially contribute to the long-term decarbonisation of the energy system in a safe, efficient and secure way.

The evaluation addresses the competitive activities to the extent of their effects on the operation of the JRC.

1.5. Evaluation questions

The evaluation follows the 'Better Regulation' guidelines and toolbox[13], structuring the questions around the five evaluation criteria of relevance, efficiency, effectiveness, coherence and EU added value. Specific questions have been added for the forward-looking perspective.

- Relevance: assessment of whether the objectives of Horizon 2020 and Euratom research and training programmes have been met;
- Efficiency: the relationship between the resources used and the changes it is generating;
- Effectiveness: how successful the direct actions have been in achieving or making progress towards its objectives;
- Coherence: how well or otherwise the different projects work together, internally and with other EU interventions/policies;
- EU added value: assessment of the value resulting from the direct actions that is additional to that which could result from interventions that would be carried out at regional or national levels.

The overarching questions in the context of the mission of the JRC concern the relevance of the JRC to EU policy making (impact as a "strategic partner") and the quality of its scientific output ("excellence").

[13] https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox_en

1.5.1. 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 ? Did the JRC anticipate, and react appropriately to new policy needs and societal challenges?
- To what extent did the JRC reach its goal of becoming a strategic partner and more central to EU policy making?

1.5.2. Implementation: Efficiency

- Has the JRC's funding as a whole been sufficient to achieve its Horizon 2020 and Euratom objectives?
- Has the JRC attributed the funding effectively (in terms of output, quality of research and impact)?
- Has the JRC implemented its work programmes in a cost-effective manner?

1.5.3. Effectiveness

Regarding the achievements of the direct actions, to what extent have they:

- Contributed to meeting the overall and specific objectives of Horizon 2020 and Euratom 2014-2020?
    - Strengthened its scientific excellence?
    - Strengthened its role in anticipation and information, knowledge and data management?
    - Leveraged the required competences, e.g. through talent development and internal cooperation?
    - Made effective use of partnerships in the EU and beyond?
    - Promoted the integration of new Member States' / Candidate Countries' organisations and researchers in their activities e.g. regarding the implementation of the S&T components of the *acquis communautaire*?
    - Developed its infrastructures so that they are fit for implementing the programmes and respond to new priorities?
    - Supported the European Research Area, e.g. through RRI (responsible research and innovation) activities such as open access and contribution to the mobility and training of (young) researchers?
- Are the JRC's processes for planning, monitoring, reporting and evaluation appropriate, effective and transparent?
- Has the JRC followed the recommendations of the ex-post evaluations 2016-2013 and the *interim* evaluations 2014-2017?

The relevant experts should give their judgement on how the JRC's work compares to top-class work in the various fields done elsewhere.

1.5.4. Coherence

- How coherent are the direct actions in terms of synergies, overlaps and complementarities with
    - 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, regional or international initiatives?

- To what extent has JRC achieved its aim of greater interdisciplinarity and more internal cooperation for policy support?

1.5.5. EU Added value

- To what extent does the JRC research and policy support provide added value beyond what is being done in Member States? What would have happened if the direct actions had not existed? Could the stakeholders have reached their objectives through other means?

1.5.6. A Forward look

The evaluation should be completed with a forward look in which the Panel should assess:

- What are changes in priorities, organisation, processes or working methods that could be made in order to further enhance the agility, impact and efficiency of the JRC's policy support?

1.6. Evaluation and Panel, method, deliverables and timetable

The Panel will consist of 15 independent high-level experts including the Chair and Vice Chairperson. It carries out the evaluation according to these Terms of Reference, taking a thematic approach distinguishing the following five themes. :

- Resilient Europe, comprising the societal challenges 1, 6 ,7 under Horizon 2020 (Health, demographic change and wellbeing; Europe in a changing world - inclusive, innovative and reflective societies; Secure societies - protecting freedom and security of Europe and its citizens);
- Digital Transition, comprising digital, industry and space parts of the "leadership in enabling and industrial technologies" programme.
- Green Transition, comprising the Societal Challenges 2, 3, 4, 5 under Horizon 2020 (Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy; Secure, clean and efficient energy; Smart, green and integrated transport; Climate action, environment, resource efficiency and raw materials).
- Innovative Europe (Access to Risk Finance, Support to innovative SMEs), Widening participation and Strengthening ERA (1) Spreading Excellence and Widening Participation; 2) Science with and for society actions, incl. gender equality and responsible R&I; 3) Social Sciences and Humanities; 4) International cooperation).
- Nuclear safety and security (Euratom).

Horizontal issues such as impact on policy making, scientific excellence, innovation etc. should be covered under each theme.

The Panel is free to organise itself for covering these themes. The JRC assists the Panel in organising all aspects of the evaluation, makes available a secretariat to the Panel and assists in establishing the final report.

The JRC Director General will select the Panel and its Chairperson from a list of independent external experts in consultation with the Board of Governors and nominate them through expert contracts. A proper panel composition requires a balanced representation of expertise in JRC areas of activity, a balanced spread over scientific, governmental, non-governmental and private sector organisations, a balanced geographical spread, and equal gender opportunity. A minority of experts with experience from earlier JRC evaluation is an asset.

The Panel will build its assessment largely on written information in background documents, activity reports, bibliometric analyses and impact analyses provided by the JRC. To help its judgement, the Panel may want to complement desk research with visits to JRC sites to investigate specific issues, and with feedback from stakeholders and beneficiaries of JRC activities.

The Panel may hold meetings using electronic means such as audio-video conferences and use other electronic media for discussions.

The ultimate deliverable is the final evaluation report, counting a maximum of 40 pages - including an executive summary, excluding annexes - with an analysis of findings and a set of conclusions and recommendations based on evidence. The JRC will make the final report available to its stakeholders and the public.

The final report shall address the achievements under the theme "Nuclear safety and security (Euratom)" separately, as this represents the JRC's achievement under the Euratom Framework Programme 2014-2018 and its extension. What is the best format for such a distinguishable presentation is left to the discretion of the Panel.

The evaluation should start with a first session in 2021 to create full understanding among the experts about their role in the evaluation. During this session, the Panel discusses and validates the applicable methodology and the management of its work. Subsequently, the Panel may meet as often as necessary to produce the final report and address it to the JRC in time (before summer 2022).

1.7. Available sources

Available data and written information consists of:

1.7.1. Reference Documents

- Official documents that constitute the formal baseline against which the assessment shall be made (Framework Programmes, Multi Annual Work Programmes, JRC Strategy 2030);
- JRC Strategy Scorecard, 2020 edition covering 2016-2020;
- General reports and Intermediate reports on progress (e.g. Annual report, Annual Activity Reports);
- Europe 2020, A strategy for smart, sustainable and inclusive growth;
- Horizon 2020, the EU Framework Programme for Research and Innovation, and the Research and Training Programme of the European Atomic Energy Community (2014-2018, extension 2018-2020)

1.7.2. Other background documents

- Facts and figures on the JRC
- Stakeholder survey

1.7.3. Specific evaluation data from the JRC

- *Ex post* FP7 evaluation of the direct actions of the Joint Research Centre
- *Interim* Evaluation Horizon 2020 (2014-2020), direct actions of the Joint Research Centre
- *Interim* Evaluation of the Euratom Framework Programme (2014-2018-), direct actions of the Joint Research Centre
- Scientific Excellence Report 2014-2020
- Case studies of JRC's impact, together with an assessment by external experts
- PRIME (Productivity and Impact Evaluation) summary 2014-2020
    - Prime report 2014-2020

1.8. Standards

The Commission's evaluation standards aim to ensure relevant and timely evaluations of high quality and that their evaluation results are communicated to decision-makers and other relevant stakeholders in a clear and transparent manner to facilitate the use of evaluation results.

The evaluation standards are an integral part of the Commission's Better Regulation Guidelines and Toolbox which means that they are binding and that the way they are implemented may be audited on this basis.

Calendar for the *ex post* evaluation

Timeline

Preparatory activities **1-10/2021**

Approach and scope	12/2021	Approval of the DG
Terms of Reference	4/2021	Approval by Commissioner (5/2021)
Getting names for chair and panel members, collecting CVs	4/2021	Input from JRC Directors
Short list of panel members	3/2021 -6/2021	approval by DG; formal consultation of RTD; approval by BoG and Commissioner
Completion of background material for panel	9-10/2021	
Stakeholder survey in the MS	6-9/2021	In consultation with/driven by BoG

Evaluation phase

Phase I - Familiarisation with the subject/desk studies. **November 2021**

First session of the Panel – The meeting should lead to a common understanding of the purpose of the evaluation and the role of the experts. During this session, the Panel discusses and validates the applicable methodology for the management of its work (e.g. a working methodology, allocation of chapters to experts).

Phase II – Field work: analysing and synthesizing preliminary findings. Start writing the Report **Nov 2021/April 2022**

- Thematic reviews and possible complementary site visits.
- Analysis and synthesis of the findings from previous phases supplemented by additional fact-finding and interviews where needed.
- Consolidation of this information into a draft final report.
- Discussion on the main conclusions and recommendations.

Phase III. Finalisation of the Evaluation Report **April 2022/ July 2022**

- Based on the outcome and written comments on the draft Report of the previous phase, the final Evaluation Report will be prepared.

Presentation of final report to BoG **Nov 2022**

Annex II

The JRC in Horizon 2020 and Euratom 2014-2020: Facts and Figures

The JRC in Horizon 2020 and Euratom 2014-2020: facts and figures

The EU Framework Programme for Research and Innovation and the Euratom Programme for Research and Training

Report to the *ex post* evaluation panel

November 2021

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Preamble

This report provides a summary of results and developments since the *ex post* evaluation of JRC under the Horizon 2020 Framework Programme for Research and Innovation (2014-2020) and the Euratom Research and Training programmes (2014-2020). The report serves as a basis for the mandatory *ex post* evaluation of the above programmes.

Results and changes are set against the main drivers, which have come into play since 2014, namely:

the Juncker Commission: political guidelines and new working methods (better regulation) inside the European Commission (2014-2019),

the von der Leyen Commission political guidelines (2019-2024),

the orientation and organisation of Horizon 2020 (societal challenges, industrial leadership and excellent science),

new societal challenges.

Available for the panel, there is a variety of other documents[14] detailing specific aspects on performance (e.g. bibliometric analysis, case studies, report of internal evaluations), the 'Recommendations and JRC response' table on the follow-up to the external evaluations since FP7. A detailed description of the activities planned and executed for the programme duration up to the end of 2020 can be found in the JRC's (multi)annual work programmes, management plans and annual activity reports (here), as well as in the annual reports prepared for a wider public (here). Reports by evaluation theme will be made available before the thematic meetings. More detailed information and documentation can be accessed through EU Science Hub.

[14] Documentation available for the panel in the CIRCABC platform.

General background

1.1. Institutional Setting

The Euratom Treaty of 1957 set up the Joint Research Centre (JRC) to carry out 'the research programmes and other tasks assigned to it by the European Commission'. Initially focusing on nuclear standards and measurements, the JRC research programme started to diversify soon in the late 1960s and by the time of the start of the First Framework Programme (1984-1987) the ratio of nuclear/non-nuclear research in the JRC was of the order of 4:1, while, through further diversification and successive cuts in the Euratom budget by the Council, it is 1: 2.3 in the period 2014-2020.

The high-level duties behind JRC's scientific activities are to provide support to EU policies at the relevant stages in the policy cycle, while the Euratom Treaty gives the JRC a mandate to carry out a Community[15] nuclear research and training programme.

The 'intervention logic' (causal link between reason for JRC to act, inputs and impacts) is illustrated in Annex 2 – Intervention logic.

The JRC differs somewhat from the typical Commission department when it concerns:

- Financial resources: in addition to its funding through the EU budget, the JRC generates additional income through work under contract (to the amount of an additional ~15-20%).
- Governance: the JRC works with a Board of Governors composed of national representatives (no other department in the Commission has an external Board).
- Geographical spread: JRC's research infrastructures and staff are spread over six different sites in five Member States: Belgium, Germany, Italy, the Netherlands and Spain. The JRC essentially has a lease-hold on its grounds outside Brussels, it owns the buildings and is responsible for all aspects regarding the management of the sites (security, health, safety, environment, etc.).

JRC's activities and the budget are set out in two programmes of Horizon 2020, the Specific Programme implementing Horizon 2020 for non-nuclear direct research (under the Treaty on the Functioning of the European Union), and the Euratom Research and Training programme (under the Euratom Treaty). Section 11 gives an indication of the JRC's means for the

> The current mission statement was defined in 2016, introducing the concept of JRC as a 'science and knowledge service'.
>
> *As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.*

[15] 'Community' is here the European Atomic Energy Community (Euratom)

framework programme period (2014-2020).

In addition to the programme cycle of the Framework programmes, the JRC has to follow the programming cycle of the European Commission which is based on political priorities and includes internal management aspects (Strategic Planning and Programming Cycle).

1.2. The relation between direct and indirect research

The arrival of the framework programmes in 1990 gave birth to the direct and indirect research concept, characteristic for Community research. All direct research activities under the framework programmes are pursued by the Commission in the establishments of the JRC, whereas indirect research is conducted in research centres, universities or undertakings, with financial support from the Commission, through DG for Research and Innovation. While both direct and indirect research activities have a vital role to play in supporting EU policy, direct research carried out by the JRC has a distinctive role in support to policy, because the JRC:

- operates independent of national, private or civil society interests,
- ensures continuity in support to policy, rather than for a limited period of a grant or contract,
- is able to respond more quickly to new priorities and changing policy support demands than indirect research tools or contracts.

Cooperation with DG for Research and Innovation

Over the last few years, the relations with the DG for Research and Innovation have intensified. During the Horizon 2020 framework programme (managed by DG Research and Innovation), the JRC played an active role as a member of project consortia, performed research actions in several thematic areas and acted as an interface between the scientific community in projects with JRC involvement and the EU policy-makers.

With the development of a new framework programme for 2021-2027, called Horizon Europe, the JRC and DG for Research and Innovation enhanced their collaboration also at strategic level. For example, the JRC became an integral part of the Horizon Europe's governance structure. As part of its science and knowledge services, the JRC has been contributing to the co-creation of the Horizon Europe's Strategic Plan and individual work programmes. It has been creating synergies with its own direct actions and the actions planned for the new Horizon Europe Missions (e.g., Knowledge Centre on Cancer supporting the Mission on Cancer, or the EU Soil Observatory supporting the Mission on Soils). And via modified participation (no funding by DG for Research and Innovation) in strategically selected calls, the JRC also maintains relations with excellent research consortia, while taking into the consideration its new role in the strategic coordination of the research and innovation programme.

Beyond the support to the development of the Horizon Europe, a new collaboration framework for cross-cutting areas was developed with DG for Research and Innovation in order to foster collaboration on data and knowledge sharing; monitoring, evaluation and assessment of Horizon Europe; or feeding the relevant research results back to policy. Since 2019, the JRC and DG for Research and Innovation are participating in drafting the Euratom parts of their respective work programmes.

The strengthened interaction between JRC and DG for Research and Innovation led to:

- 'Commission Communication on the Global Approach to Research and Innovation';

- formulation and implementation of the Commission's Communication on the revamped European Research Area;
- 'Communication on a new innovation strategy: towards a pan-European innovation ecosystem'.

1.3. JRC contribution to the Commission Scientific Advice Mechanism

The JRC welcomed the establishment in 2015 of the Scientific Advice Mechanism (SAM) as it serves to better organise the provision of science advice external to the Commission, thereby complementing JRC's role in providing evidence to inform policymaking from within the Commission. The SAM also provides an additional channel for presenting JRC's work, via the SAM High-Level Group (HLG) of eminent scientists.

Close and successful cooperation between the JRC and the SAM Unit (in DG for Research and Innovation) has been established, notably via seconding three JRC staff members to the SAM Unit, participation in the SAM inter-service group and monthly meetings between the JRC and the SAM Unit.

The JRC has also provided expert advice on all SAM-HLG topics (such as: CO_2 emissions from vehicles under real-world driving conditions, cybersecurity, new techniques in agricultural biotechnology, food from oceans, microplastic pollution, towards an EU sustainable food system, adaptation to health effects of climate change in Europe, improving pandemic preparedness and management, scientific advice to European policy in a complex world and biodegradability of plastics in the open environment), proposed future topics and has implemented tools such as the TIM (Technology Innovation Monitor) and EMM (Europe Media Monitor) that have been used by SAM to extract supporting information. A preliminary screening inside the JRC resulted in several ideas (quantum technologies, the circular economy, adaptation to climate change, and risk assessment for decision making, in particular in relation to toxicological hazard assessments).

Stakeholders

Outside the European Commission and the budgetary authorities (EU Council and European Parliament), the JRC works with stakeholders in different configurations:

- on a voluntary basis, for research purposes (e.g. data provision/ sharing/research cooperation/access to JRC infrastructures and testing facilities),
- in many cases, it acts on a mandate from the European Commission for regulatory purposes (e.g. the case of the vehicle emissions or industrial emissions),
- offering, or being sought after, for delivering specific services to public bodies (e.g. support to macro-regions).

JRC's relations with international partners are regularly reviewed by the Board of Governors. The last review, in November 2019, confirmed the validity of the approach, with some adjustments. The relative importance of stakeholders, in terms of the distribution of the use of JRC's work, is given in Section 10.

Such engagement has ensured access to global knowledge, contributed to enhancing EU's influence in the world and opened opportunities resulting from international cooperation. The international partnerships developed by the JRC are recognised and appreciated by the European External Action Service and by policy DGs, they provide a tangible contribution to the development of meaningful engagement with the EU's strategic partners. In particular, they support strategic dialogues in areas such as **nuclear non-proliferation, space, environment, energy, science, technology and innovation**. Several processes and methodologies authored by the JRC are transposed/adapted by international partners (e.g. INSPIRE, smart specialisation), contributing to EU's international projection.

JRC's engagement on the international scene has led to the development of **strong scientific partnerships** in both nuclear and non-nuclear fields with leading institutions in key priority countries (e.g. USA, Brazil, China, India, Japan, South Africa), with the Western Balkans and Eastern and Southern Neighbourhood countries, with international organisations (e.g. United Nations, Organisation for Economic Co-operation and Development, World Bank, International Atomic Energy Agency) and regional entities (e.g. African Union Commission, Community of Latin American and Caribbean States, Association of Southeast Asian Nations). In addition, the JRC has extended its collaboration with strategic partners in South Korea.

> EU Institutions and agencies, Member States, candidate and associated Countries, international organisations, partner organisations from public and private sectors across Europe and the world are among the stakeholders, partners and customers of the JRC.

2.1. EU Institutions and agencies

The JRC also interacts with many of the EU institutions:

- the European External Action Service (EEAS),

- the European Council in several of its formations[16] and its Secretariat,
- the European Parliament[17],
- the European Economic and Social Committee and the Committee of the Regions,
- the European Central Bank and the European Investment Bank, many of the 37 decentralised EU Agencies[18] through the responsible Directorates General in the Commission, EEAS or Council.

Relations with the EU institutions

Working relations with the **Council's Research Working Party and the Space Working Party** have been maintained through their visits to JRC sites and by presenting JRC's work in the Working Party meetings. Each semester, JRC working breakfasts have been also organised with Members of the Research Working Party to highlight JRC's relevance and work and to promote JRC's activities to Member States.

2.2. EU Member States

The JRC, in collaboration with the European Parliament and the Committee of the Regions, took initiatives to build closer links between scientists and EU policy makers and promote a culture of evidence-informed policymaking. These initiatives resulted in the pilot project '***Science meets Parliaments / Science meets Regions***' carried out in 2018-2019. 27 very successful events were organised in 23 member states and associated countries, giving to scientists the opportunity to present their work, while allowing policymakers to communicate their needs and explain their priorities. Proposals for new projects are being collected in late 2021.

Cooperation with, and services for, this group of stakeholders is vital for the legitimacy, relevance and credibility of the JRC.

A **Board of Governors** (see section 3.2) assures the continuous, close link of the JRC to EU Member States and Associated Countries. Furthermore, the JRC maintains an active dialogue with the **Network of JRC's National Contact Points** in all Member States and Horizon2020 associated countries. The network informed its scientific communities, as well as public entities, about JRC's initiatives, events and possibilities for cooperation with the JRC.

The JRC supports the **EU Member States** with the implementation of the regulations (e.g., reporting of land-use in agriculture, smart specialisation), builds capacity through training, information systems and related services (e.g. the Copernicus Emergency Management Service), and provides access to its data and knowledge, best practices and selected research infrastructures.

[16] Mainly the Working Party on Research, the Joint Working Party on Research/Atomic Questions, the Working Party on Atomic Questions.

[17] The JRC-EP Interface Working Group to inform parliamentarians of the JRC's activities and to understand the Parliament's position on policy issues and there is regular exchange of information and collaboration with the EP Science and Technology Options Assessment (STOA) panel.

[18] For example the European Environmental Agency (EEA), the European Food Safety Agency (EFSA), the European Chemicals Agency (ECHA), the EU Satellite Centre (EUSC), the European Agency for the Management of Operational Cooperation at the External Borders of the EU Member States (Frontex).

2.3. International organisations

The JRC works with a large number of international organisations and standardisation bodies. In the nuclear area it maintains strong ties with the International Atomic Energy Agency. More in general it has standing relations with the United Nations (UN) and several of its bodies such as the UN Environmental Programme and the UN Economic Commission for Europe, the Organisation for Economic Co-operation and Development and the World Bank, as well as specific European intergovernmental organisations like the European Space Agency or the European Organisation for the Exploitation of Meteorological Satellites.

The JRC supports international standardisation through e.g. the European Committee for Standardization, the International Organization for Standardization, and the 'Codex Committee on Methods of Analysis and Sampling' of the Codex Alimentarius Commission, established by the FAO and the WHO.

2.4. Partner organisations from public and private sectors

As a networked organisation the JRC cooperates with numerous partner organisations across Europe and worldwide. These cooperating partners range from academia, industrial companies and associations, to regulatory bodies (e.g. control laboratories) and citizens. Through more than one hundred networks and cooperating with an order of magnitude more research organisations worldwide, the JRC multiplies the Commission's influence among the global scientific community.

The JRC maintains close links with umbrella organisations of the European scientific community, including, for example, the European Academies Science Advisory Council, the European Council of Applied Sciences Technologies and Engineering, the League of European Research Universities, the Conference of European Schools for Advanced Engineering Education and Research.

At international level, the JRC cooperates with institutions in the USA, Brazil, China, India, Japan and South Africa, ensuring access to global knowledge, enhancing the EU influence in the world.

Organisational structure and governance

3.1. Organisational structure

To adapt to changing societal challenges and political priorities, and in response to a recommendation of the FP7 *ex post* evaluation, the JRC developed a long-term strategy (JRC Strategy 2030) followed by a fundamental reorganisation (2016). This was motivated (1) by re-orienting the JRC towards a broader role of knowledge production and management, with enhanced cooperation, (2) giving JRC knowledge production directorates (the former Institutes) a more streamlined portfolio by re-allocating research teams and/or units, (3) enhanced efficiency of support services.

> Four functional entities have been set up in 2016: strategy and coordination, knowledge production, knowledge management and resources.

A new business model is reflected in its new mission, according to which the JRC will complement the knowledge it created itself by managing knowledge and communicate it to policy-makers in a systematic and digestible way. Knowledge Centres and Competence Centres are being set up selectively, the former in policy areas where there is need for integrated knowledge, the latter where there is a significant cross-cutting need for specific competences of the JRC.

The strategy and organisation are currently under review. The current organigramme is given in Annex 1 - Organigramme.

3.2. Governance

Until 2014, the JRC reported to the **Commissioners** responsible for Research. During the Juncker Commission (2014-2019), the JRC was attached to the Commissioner for Education, Culture, Youth Sport, who also took the responsibility for another part of Horizon 2020, the European Institute for Technology. The mission letter of the Commissioner set out that the JRC should support all Commission services with its scientific and technical knowledge and expertise, sharing its result with a wide public. Under the von der Leyen Commission (since 2019), the JRC reports to Vice-President Šefčovič, as regards strategic foresight, ensuring that Commission policies are underpinned by scientific evidence, and to Commissioner Gabriel (Innovation,

Research, Culture, Education and Youth) for the overall policy support.

A **Board of Governors** provides an external element in the JRC governance. Member States and Associated Countries nominate their representatives and the Commission appoints the Governors. Associated Countries have an observer status in the Board. The Board meets three times a year, it assists and advises the Director General on matters relating to the role and the scientific, technical and financial management of the JRC and communicates back to the Member States and Associated Countries. The Board also gives an opinion on Commission decisions that have a direct impact on JRC programming including senior management appointments.

Scientific Committee

In 2014, the Director General revitalised the JRC's Scientific Committee, after several years of suspended activity, and established a position for a JRC Chief Scientist. The Committee and the Chief Scientist advise the Director General on all aspects of the scientific life of the JRC, thus helping to ensure that the JRC achieves its mission, scientific excellence and, on that basis, maximises its scientific and technical support to European Union policy. In particular, the Committee supports the Director General by providing advice on the work programme, on how to promote and achieve multi-disciplinary, cross-JRC collaboration, selecting exploratory research projects, and defining ways and means to assure the scientific integrity of the JRC.

The Scientific Committee has played a vital role in developing and overseeing institutional instruments, particularly for:

- the formation of a JRC dynamic research landscape - the Scientific Committee has, *inter alia*, participated in the development of some of JRC's programmes such as the Exploratory Research programme, the Centre for Advanced Studies, the Collaborative Doctoral Partnership and the Visiting Researcher Programme.
- Fostering scientific excellence – the Committee has launched the bi-annual reporting on JRC Excellence in Science for Policy, established an annual programme for JRC Awards for Excellence, developed a code of practice for JRC Research Fellows and participated in a considerable number of related evaluation campaigns.
- Ensuring JRC scientific integrity and research ethics – the Committee has developed fundamental pillars for JRC scientific integrity and research ethics, the JRC Editorial Review Board, the JRC Research Ethics Board, as well as guidelines on responsible conduct of research.

The political drivers: the Juncker and von der Leyen Commissions

4.1. Policy orientations

Both the Juncker (2014-2019) and the von der Leyen (2019-2024) Commission set out their priorities (10 and 6, respectively, Table 1), influenced by long-term challenges (e.g. climate change, energy transition, digitisation,), imminent events (e.g. migration, security, COVID-19 pandemic since 2020) and the need to modernise internal working methods. Details of how the JRC adjusted and contributed to the different priorities, policy initiatives and their implementation are given in Chapters 8 and 9 (JRC positioning in the framework programmes and its support policy) and in paragraph 11 (JRC's resources).

Figure 3. Pictorial representation of megatrends identified in the Strategic Foresight Report 2021, to which JRC was an important contributor.

A particular task for the Juncker Commission was to propose the programmes and budget for the next programming period 2021-2027 (multiannual financial framework (MFF)).

This was submitted in 2018 and adopted under the von der Leyen Commission after

revision in 2020, in particular for the recovery and growth facility.

Table 1. President Junker's and von der Leyen's political priorities

President Juncker's political priorities (2014-2019)	President von del Leyen political priorities (2019-2024)
A new boost for jobs, growth and investment	A European green deal
A connected digital single market	A Europe fit for the digital age
A resilient energy union with a forward-looking climate change policy	An economy that works for people
A deeper and fairer internal market with a strengthened industrial base	A stronger Europe in the world
A deeper and fairer economic and monetary union	Promoting our European way of life
A balanced and progressive trade policy to harness globalisation	A new push for European democracy
An area of justice and fundamental rights based on mutual trust	
Towards a new policy on migration	
A stronger global actor	
A Union of democratic change	

4.2. Commission working methods

The challenges faced by the EU require fast and effective solutions from the Commission, often involving multiple policy areas and departments. In addition, the increasing amount of data coming from many different, official and unofficial sources ('big data') makes it imperative to have appropriate means for collecting, validating, sharing and making sense of such data. Therefore, President Juncker's mission letters to all Members of the College called for a modernisation of the Commission's ways of working, with a strong emphasis on teamwork, overcoming silo mentalities and harnessing synergies between portfolios.

The Juncker Commission introduced:

- a renewed emphasis on better regulation to improve the quality of EU legislation. The better regulation initiative has focused the Commission work programme on highest priorities, significantly reducing the number of legislative proposals. In addition, measures have been taken to improve the quality and transparency of impact assessments, through revised guidelines and an independent Regulatory Scrutiny Board. The von der Leyen Commission introduced a stronger emphasis on the use of evidence and foresight for policymaking.
- Improved political steer at the level of the Commissioners via Project Teams comprising the relevant Commissioners and improved coordination among the Commission

departments (Directorates-General) through a more central role of the Secretary General. These developments have facilitated the JRC taking a more direct and visible role in support to policymaking.A corporate strategy for developing and managing data, information and knowledge, set out in October 2016[19]. It identified four main areas for improvements: information retrieval and delivery, working together and sharing information and knowledge, maximising use of data for better policy-making and creating a culture of knowledge sharing and learning. An Information Management Steering Board (IMSB) was established, chaired by the Deputy Secretary General and comprising representatives at DG level from 18 Directorates-General, including the JRC Director General.

- Taking advantage of scientific expertise in the Member States. Following the end of term of the European Commission's Science Advisor, the Commission established a Scientific Advice Mechanism, including the SAM High-Level Group (HLG). This action consists of seven highly qualified, specialised, independent experts appointed in their personal capacity and who are to act independently and in the public interest.

[19] Commission Communication C(2016) 6626 final.

The project cycle and quality management

5.1. Project planning, monitoring and evaluation

As a follow up to recommendations of the last *interim* evaluation of the Euratom direct actions and the audit by the Commission's Internal Audit Service on scientific project management (SPM), the JRC started an improvement process to set up a project management methodology suited for its scientific activities. Based on the proposal of a working group comprising a large number of representatives of various stakeholders, a methodology based on the Commission's Project Management Methodology (PM^2) was adapted to the JRC. The new methodology introduces as two artefacts supporting project detailed planning: the project handbook and the project work plan.

With a view of harmonising approaches across the JRC, a comprehensive set of guidance notes was released, including a new terminology for the work programme structure elements (i.e. project portfolios and projects), a manual, procedures and required templates. Also, the clear definition of roles and responsibilities for all actors involved for the entire project life cycle is now demanded.

The methodology was integrated into the processes of the work programme cycle and was used for the first time in 2021-22. To support the adoption of the new methodology, a series of training course was offered from September 2020 to June 2021. Around 400 staff members participated, of which 100 middle managers.

The tool for managing the JRC work programme (i.e. JRC Project Browser) is being extended with the implementation of project management modules to support the effective management of detailed planning, execution and monitoring of scientific projects by end of 2021.

5.2. Quality assurance and quality system

In view of delivering consistent and high-quality technical and operational results, the JRC pursues a quality management approach, where necessary backed up by external certification and accreditation (ISO 9001, ISO/IEC 17025, ISO 14000, OHSAS 18001, ISO Guide 34 and ISO Guide 43). This rigorous quality approach (which covers

processes, documentation, instruments, products, customer feedback etc.) also facilitates JRC's recognition as a reliable provider, when it operates on the (commercial) market. In the period concerned, JRC set up an integrated management system based on ISO 9001 with some remaining local (site-based) approaches being gradually phased out.

The **Integrated Management System** (IMS) was launched in 2012 aiming at integrating all ISO 9001 systems in one, managed centrally. The increase in harmonised practices via the IMS contributes to more efficient and effective (harmonised) working practices including improved monitoring which, in turn, will lead to improved organisational knowledge, in view of anticipating changes and weaknesses. The developed IMS is certified for ISO9001:2015 for the JRC. Additionally, through the process-oriented approach of ISO 9001:2015, compliance with other specific standard requirements is provided.

Additional upstream measures include, for example, peer reviews, or advisory boards, of some major computational models. In 2020 the JRC Director General established the JRC Editorial Review Board (JERB). It consists of the Editor in Chief who reports directly to the Director General, 9 editors from each of the knowledge producing directorates and draws on 120 dedicated JRC reviewers, as well as a large number of occasional reviewers depending on the content of the manuscript. The JERB is responsible for reviewing the content of all JRC public manuscripts

Communication

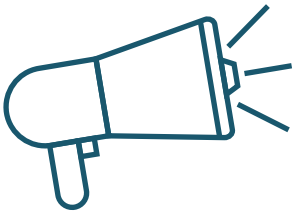
6.1. Developments in communication

Between 2014 and 2020, the JRC has taken numerous, tangible steps to improve communication and has also contributed to several EC corporate communication campaigns at the EC level. There was an increased emphasis on communicating in comprehensible language, using powerful infographics and data visualisation tools, as well as by organising face-to-face, virtual and hybrid events.

Following new Commission Spokesperson's service rules, starting from 2014, before they could be published, all JRC headlines and journalist requests were first vetted by the policy DG and then by the spokesperson. This lead to a better coordination with policy DGs and to a higher awareness of the policy-relevance of JRC's communications. Other focus areas in this field include to:

1. increase visibility and consultancy for use of research specific social networks like Research Gate and Instagram
2. provide better coverage at flagship events.

Figure 4 provides an overview of JRC's communication activities. Further details are included in Annex 6 – Communication initiatives and Writing with Impact.



Items on EU Science HUB per year 100+

Mentions of JRC's work in the media 100+

Social media visibility +2500%

Press visits to the JRC 3 per year

Communication on COVID-19 to support the Commission

Figure 4. Overview of JRC's communication activities.

6.2. Profiling and branding

In 2020, together with DGs for Education, Youth, Sport and Culture and Research and Innovation, the JRC led the establishment of the '**Commissioner's monthly update**' newsletter. The Commissioner shares the latest news from across her portfolio with approximately 4.5k subscribers. The JRC's leading role on the content helps to cement its profile as a key service bringing solid evidence and expertise to help the Commission achieve its priorities.

The digital presence aims to promote the JRC as one of the leading organisations in transforming scientific knowledge into policy advice. In line with the European Commission-wide web rationalisation and digital transformation programme, the JRC develops an EC-branded '**Web presence**

for knowledge services' platform on EUROPA website. This is helping to integrate the existing JRC websites into a wider network, yet keeping the focus on engaging science/policy communities and supporting the interactions and transfer of science knowledge into policy processes.

Starting from 2018, the JRC launched a series of **flagship reports**, to analyse global, transformative trends that challenge the EU. By providing thorough evidence, their aim is to help the Commission deepen its understanding of crucial issues for Europe in the years to come. Each flagship report is presented at a dedicated launch event or in the frame of political events. On social media, the 10 reports published (Annex 7 – List of Flagship Reports) had a reach between 0.2 – 1.6 M. On line, the individual reports were viewed by between 350 and 5000 readers, in addition to around 3000 hard copies.

The **monthly JRC Digital Newsletter**' was launched in 2015. Since then the audience has grown substantially and reached more than 26 000 subscribers in 2020. The **Science Flash Newsletter**, established in 2020 to communicate the JRC's research reached around 4 500 subscribers. In 2020, the **Euronews** network covered the JRC in three episodes of its 'Futuris' TV programme.

6.3. The views of stakeholders

Two approaches have recently been introduced to assess the perception of stakeholders in the European Commission:

1. feedback on impact case studies which cover 2014-2020,
2. continuous feedback based on outputs delivered.

49 feedback surveys have been collected covering 36 case studies out of 49. In total, 29 DGs provided their feedback and about 96% of respondents strongly agree or agree that the JRC provided solutions/evidence that were relevant and of high scientific quality (Figure 5). In addition, 80% of respondents strongly agree or agree that the JRC provided innovative solutions to technical problems. For 82% of them the JRC provided timely solutions/evidence. Finally, for 94% of the respondents, the JRC met the expectations, in some cases exceeding them.

These results mirror those of a (limited) sample based on outputs delivered in the frame of administrative arrangements.

The JRC was recognised as one contributor of evidence/technical support among other actors for 45% of respondents (Figure 6). In addition, 41% of them indicated the JRC as the main contributor, while it was the sole contributor of evidence/technical support according to 8% of respondents. This can be attributable to the variety of activities performed by the JRC, which is dependent on the involved policy areas.

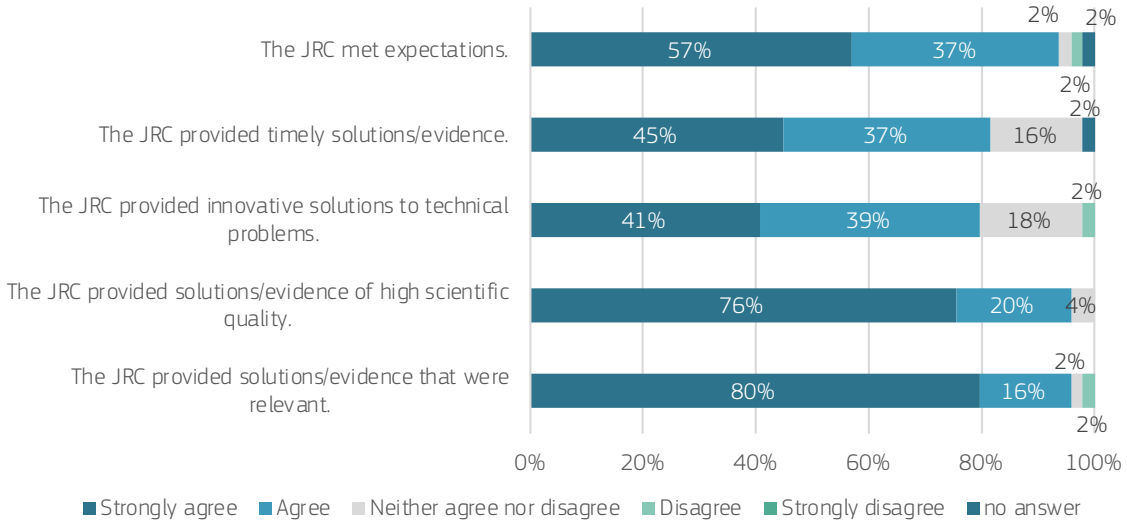


Figure 5. Results of the stakeholder survey - selected questions.

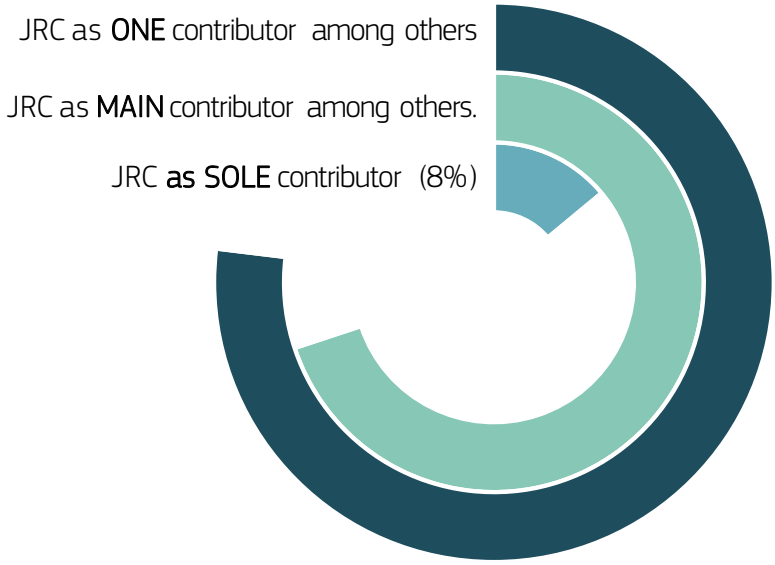


Figure 6. Results of the stakeholder survey – What was the extent of the JRC's contribution in relation to other actors?

The JRC in Horizon 2020

7.1. Objectives and KPIs

While the JRC contributed to all parts of Horizon 2020, its main contribution was to the part 'Societal challenges', including:

- health, demographic change and wellbeing,
- food security, sustainable agriculture, marine and maritime research and the bio-economy,
- secure, clean and efficient energy,
- smart, green and integrated transport,
- climate action, environment, resource efficiency and raw materials,
- inclusive, innovative and reflective societies.

Two key performance indicators were defined and included in the legal basis with yearly targets. The indicators were monitored once per year, as reported inTable 2.

Overall, across the period 2014-2020, indicator 1 shows consistently higher values for 2015-2020 than 2013-2014. In 2020, the higher value results from JRC's direct support to a number of factors (see section 11.1).

Table 2. Horizon 2020 indicators as included in the legal text and their values for the time range covered by the framework programme.

Indicator 1: Number of occurrences of tangible specific impacts* on European policies resulting from technical and scientific policy support provided by the Joint Research Centre							
Baseline	Milestones						Target
2013	2014	2015	2016	2017	2018	2019	2020
248	275	305	376	339	338	303	513

*By impact is meant the use of JRC results for policy preparation (e.g., impact assessments), monitoring (e.g., COM reports), implementation (e.g., methods, materials, guidance) and evaluation

Indicator 2 : Number of peer reviewed publications in high impact journals§							
Baseline	Milestones						Target
2013	2014	2015	2016	2017	2018	2019	2020
460	465	518	553	515	538	522	548

§The indicator counts the peer-reviewed articles published within a given year in journals, the titles of which are listed in the Thomson-Reuters Science Citation Index Expanded (SCI-e) and/or Social Science Citation Index (SSCI)

7.2. Design of the JRC work programme

JRC's work programme is a rolling bi-annual plan, organised around Commission's priorities. It describes research activities and services supporting EU policymaking.

Its political relevance is ensured through bilateral meetings with policy DGs throughout the year, round-tables with groups of policy DGs and a formal inter-service consultation before its adoption.

Despite the formal process of adoption, JRC's work programme is a flexible instrument that can be updated in response to emerging opportunities, crises, threats and policies.

Under Horizon 2020, the work programme was increasingly designed in collaboration with the other Commission departments (Figure 7). Since the proportion of co-designed projects was above its target of 80%, the investment in basic and underpinning research has been increased from 2016 onwards.

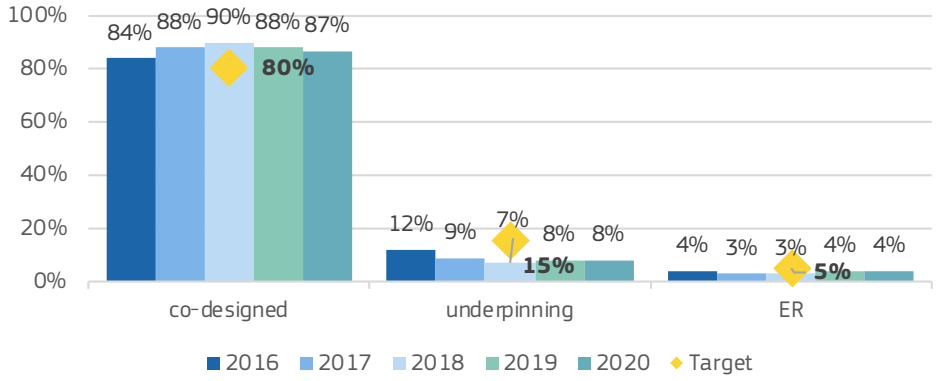


Figure 7. Design of the JRC work programme, showing its percentage of co-design with other policy DGs, the part dedicated to underpinning and exploratory research.

7.3. Main lines of evolution 2014-2020

During 2014-2017, the JRC has reallocated staff resources with a view to enhancing:

- socio-economic research, particularly on pressing issues such as demography and migration,
- research on resilience and fairness-related issues, resulting in a better balance with issues related to competitiveness,
- support to the Commission working methods (better regulation), the European Semester and the Multi-Annual Financial Framework, under the responsibility of central services (DG BUDG, SG).

Resource re-allocation was accomplished reattributing positions of staff leaving and closing of some activities. There was a considerable reduction (-9%) in staff allocated to environment and to health and food safety. Activities phased out include three European Union Reference Laboratories, which carried out controls to ensure the harmonised application of EU food and feed safety regulations. The strongest relative increase (+7%) was in cross-cutting activities for better regulation including knowledge management and anticipatory work. 9% of staff was shifted to the areas of internal market and industry, financial stability and markets, regional policy, and security and migration. An overview of the resources allocated to the activities related to the various von der Leyen political priorities is shown in Figure 8.

The reprioritisation is reflected in shifts in outputs and impacts (see sections 10 and 11.2).

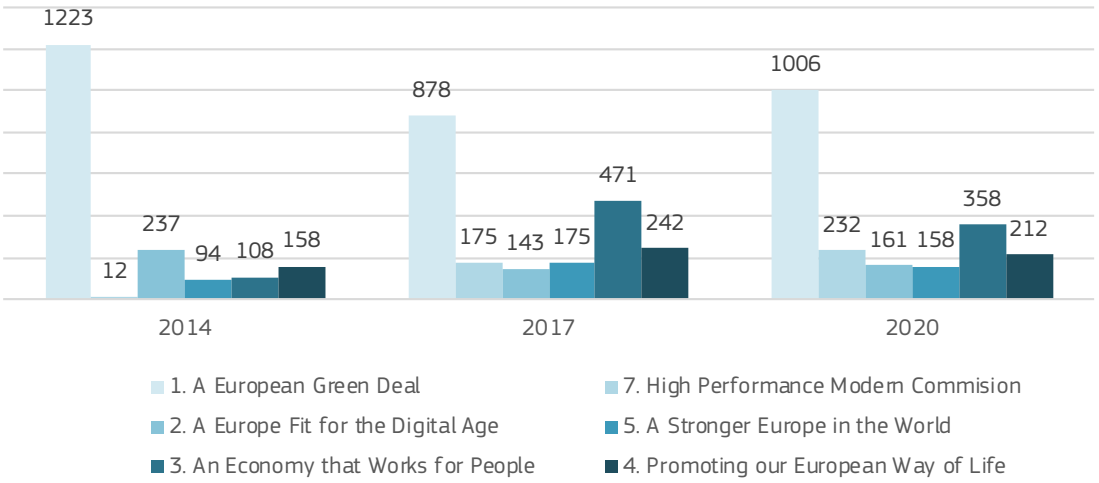


Figure 8. Resources by political priorities (JRC work programmes 2014-2017-2020)

New areas of research

A number of new research activities were started in response to new or urgent societal challenges (migration and demography), policy needs (market surveillance of vehicle emissions) and technological developments (quantum technologies, blockchain, artificial intelligence).

Similarly, a number of new laboratories were constructed related to the electrification of transport and the digitisation of the electricity grid (Electric and Hybrid Vehicles Testing Facility; E-Mobility Electromagnetic Testing Facility; Smart Grids Interoperability Laboratories; Battery Energy Storage Testing).

Activities phased out

The JRC has phased out or is phasing out work, either because it is no longer policy relevant or, in line with a policy in the JRC Strategy 2030, because it has become routine and can be taken on by other organisations. Examples are the transfer of 3 European Union Reference Laboratories and of a number of EU-wide accident reporting systems.

Examples are given in Annex 3 – Activities phased out.

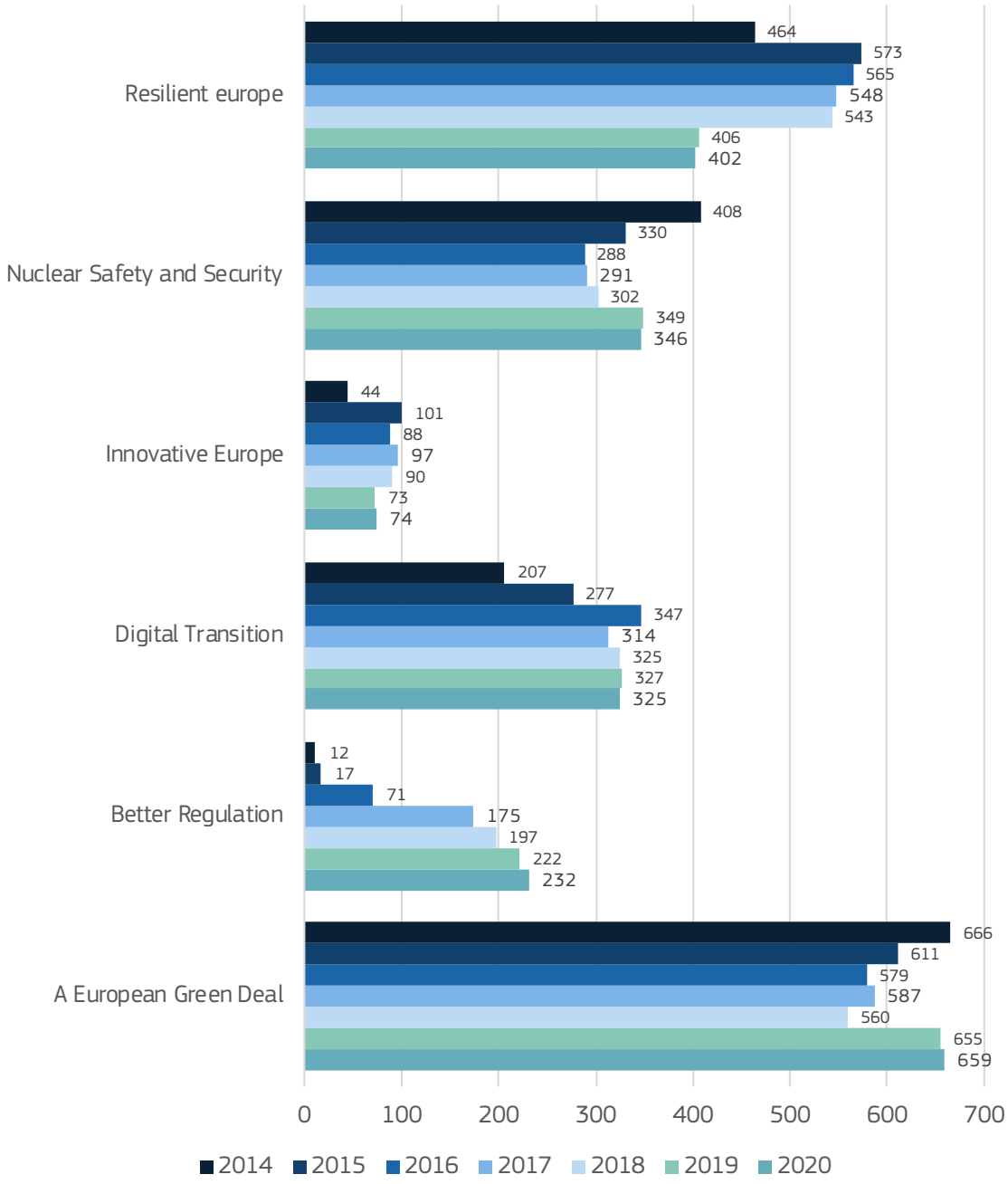


Figure 9. Resources (expressed in full-time equivalent) allocated to the ex post evaluation themes.

7.4. Responsible Research and Innovation

Horizon 2020 contains a 'Responsible Research and Innovation' principle whereby researchers, policy-makers and other societal actors are encouraged to better align research and innovation and their outcomes with the values, needs and expectations of the society. This means steering research activities to include public engagement, to promote science education and to advance gender equality, ethical behaviours and open access to knowledge and data.

These elements are largely addressed by the JRC Strategy 2030. For example, the JRC has shifted resources to strengthen the **fairness dimension**. An important milestone was JRC's supporting role for the

European pillar of social rights package, adopted by the Commission in April 2017. The JRC developed a social scoreboard to monitor the implementation of the package, including the fairness dimension.

During Horizon 2020, JRC has explored ways to respond to a new wave of engagement of citizens in the policymaking processes, anticipating to large extent the political priority a 'new push for democracy', including ideas of deliberative democracy. In particular, the JRC contributed to draft the new European Democracy Action Plan (COM(2020)790) including provisions for civic engagement beyond voting in Member States. Since early 2019, JRC has been advising different Commission initiatives to step up citizen engagement beyond consultation at different phases of the policy cycle. To name a few, the Conference on the Future of Europe, EU Missions in Horizon Europe, Pollinators initiative, Climate Pact and others. In addition, the JRC has been part of the advancement of the Responsible Research and Innovation framework, not only participating with other EU partners on developing participatory methodologies but also directly supporting research and innovation, developing evaluation frameworks, especially for the public engagement pillar. Furthermore, the JRC has developed a toolkit for researchers to conduct their research based on responsible research and innovation principles. Under the next framework programme, Horizon Europe, the JRC will further consolidate its response to this institutional request with both a theoretical underpinning framework and an operational agenda, establishing a new Competence Centre on Participatory and Deliberative Democracy.

Open access to publications

Under Horizon 2020, it was foreseen that each beneficiary ought to ensure **open access** to all peer-reviewed scientific publications relating results reached/obtained via a project funded under the framework programme.

Following this requirement, the JRC has been increasingly publishing its publications adopting an open access policy. The proportion has doubled from roughly 30 to 60%, as regards all types of publications with at least one JRC author.

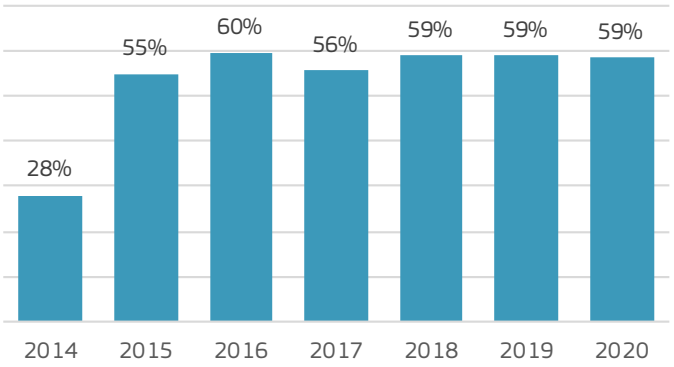


Figure 10. Proportion of publications in open access mode

The proportion increases up to almost 98% for the more restricted set of peer-reviewed publications submitted directly by the JRC (i.e. with the corresponding author affiliated to the JRC).

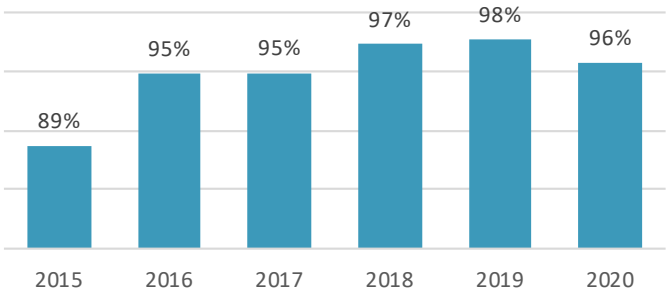


Figure 11. Peer-reviewed articles, with corresponding authors affiliated to the JRC, published with open access

Scientific Integrity and Research Ethics

The JRC has established a framework for **Scientific Integrity and Research Ethics** (SIRE) including a set-up of instruments to ensure compliance with world standards and best practices on scientific integrity and ethics. The framework determines the JRC's commitment to scientific integrity and ethics and helps to manage potential risks from both inside and outside of science and JRC.

The different elements of the SIRE framework and their functions are:

- The Scientific Integrity Statement – as a baseline document
- Scientific Integrity Counsellor – person of confidence to whom staff members can report issues and incidents of possible non-compliance with the principles of scientific integrity.
- Editorial Review Board – to ensure that JRC scientific publications meet established JRC quality and integrity standards.
- Research Ethics Board – to ensure that JRC research conforms to research-ethics standards in Horizon 2020/Europe.
- Research Data Management – to promote transparent and good administrative practice in order to improve management of and access to JRC data with FAIR Data principles (Findable, Accessible, Interoperable and Reusable).
- Responsible Conduct of Research, guidelines, information, and training – information and training on how to act correctly on scientific integrity and research ethics matters, for example on authorship, plagiarism and duplicate publication.

The JRC in Euratom

The Euratom Treaty establishes that the Commission is responsible for promoting and facilitating nuclear research in the EU Member States and for complementing it by carrying out a Community research and training programme.

> The overall objective of the Euratom Research and Training Programme is:
>
> 'to pursue nuclear research and training activities with an emphasis on the continuous improvement of nuclear safety, security and radiation protection, in particular to potentially contribute to the long-term decarbonisation of the energy

The research activities in the Euratom Research and Training Programme 2014-2018[20] and its extension 2019-2020[21] are structured in nuclear fusion and nuclear fission. The nuclear fission research is carried out through indirect actions (activities carried out by consortia of research institutions from EU Member States and associated countries, partially funded by the EU research budget) and direct actions (activities in nuclear fission carried out by the European Commission's Joint Research Centre).

The Joint Nuclear Research Centre (JRC) was established by the Euratom Treaty (art. 8), to ensure that the research and training programme and other tasks assigned are carried out. Along the time, the research fields broadened, being currently the nuclear disciplines around 25% of the JRC activities.

8.1. Objectives and KPIs

In a perspective of continuity, the extension of the Euratom Programme for 2019-2020 allowed to carry over the activities of the 2014-2018 programme, keeping the same strategy, scope and mode of implementation. The Programme's education and training activities continued, reinforcing knowledge management and improving open access of scientists to JRC research infrastructure. Deeper integration of direct/indirect actions was pursued to increase synergies between the nuclear and the non-nuclear research.

The 2014-2018 programme describes a list of specific objectives for each approach (direct and indirect).

The objectives for the direct actions are:

- improving the safety of nuclear systems, including nuclear reactor and fuel safety as well as emergency preparedness, and nuclear waste management including final geological disposal as well as partitioning and transmutation;
- improving nuclear security, including nuclear safeguards, non-proliferation,

[20] Council Regulation (Euratom) No 1314/2013 of 16 December 2013 on the Research and Training Programme of the European Atomic Energy Community (2014-2018)

[21] Council Regulation (Euratom) 2018/1563 of 15 October 2018 on the Research and Training Programme of the European Atomic Energy Community (2019–2020)

combating illicit trafficking, and nuclear forensics,

- increasing excellence in the nuclear science base in support of standardisation. Contribute to the further development of medical applications of radiation.
- fostering knowledge management, education and training,
- supporting the policy of the Union on nuclear safety and security.
- The key performance indicators for the Euratom Research and training programme were defined similarly to those for the 'non-nuclear' programme.
- Over the period 2014-2020, JRC achieved:
- 97% of the target of 1170 peer-reviewed publications;
- 75% of the target of 440 tangible impacts on policymaking;
- 86% of the target of 2039 outputs (see Figure 13 for description of categories).

The trend is shown in Figure 12.

The average annual numbers are 162 peer-reviewed publications and 53 policy impacts. The performance is below targets since 2019 (for publications) and 2018 (for policy impacts).

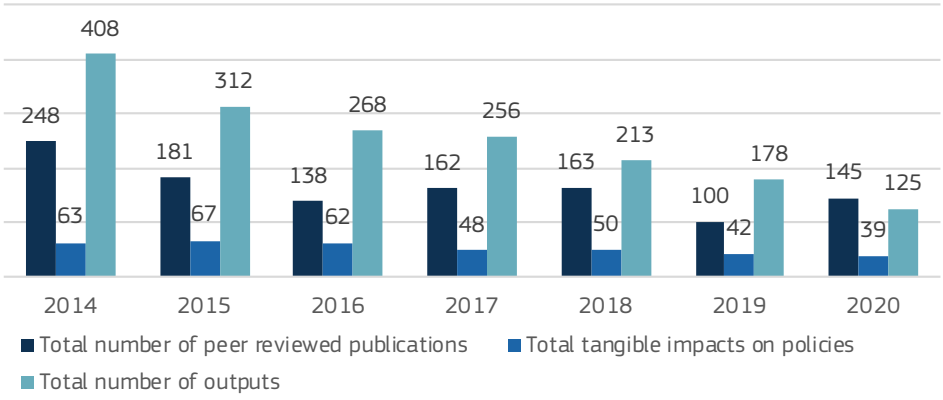


Figure 12. Euratom programme indicators - trends over the FP period.

8.2. Design of the Euratom contribution to the JRC work programme

Within the framework of the objectives and scope of the Euratom Programme, JRC's nuclear research and training activities must be in line with and complement the research and training needs of EU Member States. In order to identify the critical areas and have a European dimension, the JRC has made efforts to engage with stakeholders:

- the JRC is a member of technology platforms (e.g. Sustainable Nuclear Energy and Implementing Geological Disposal) and of the European nuclear education network association,
- it collaborates with European nuclear-related associations.
- The JRC concluded agreements with EU Member States institutions to enhance the collaboration, building partnerships and to align our programme with the MSs needs. It also addresses the global dimension of nuclear research, by cooperating with International Organisations, such as the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and

Development (OECD), and through ongoing agreements with institutions from United States, Japan and China.

A working group between the JRC and DG Research and Innovation has been set up in 2019 to propose ways of joint collaboration. This resulted in co-drafting the biannual work programmes of both kinds of actions and a joint review workshop in 2021, where concrete follow up actions were agreed. Table 3 summarises JRC's areas of activities related to the Euratom framework programme. The themes 'Standards for Nuclear' and 'Knowledge management, training and education' are horizontal to the entire JRC Euratom work programme.

Table 3. JRC themes under the Euratom framework programme.

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

8.3. Main lines of evolution 2014-2020

Nuclear research requires long-term investments in infrastructure and skills. The research programme has also had a long-term orientation and, over the period 2014-2020, it has been evolving and it has been gradually refocused to also cover emerging areas rather that phasing particular activities out.

In nuclear safety, the focus of the activities evolved to cover materials research oriented to the long term operation of nuclear power plants; nuclear fuel studies included research on accident-tolerant fuels and research into small modular reactors was further developed to address issues specific to this type of reactors.

In nuclear safeguards and nuclear security, the JRC developed new and alternative non-destructive neutron detection techniques and additional visual methods for surveillance as well as process monitoring coupled with data integration. It also launched an exploratory research project to analyse the possibilities offered by IT-technologies such as block chain for data safeguarding and its analysis.

The field of knowledge management received increased attention with the creation of a dedicated unit. In 2019, a joint project with DG for Research and Innovation was launched to develop knowledge management tools to make knowledge obtained through European programmes readily accessible.

The *interim* evaluation, carried out in 2017, recognised the excellent role of JRC in the area of education and training. Following the recommendation received, the activities were further reinforced and the JRC strengthened its collaboration with the

European Nuclear Education Network (ENEN). An example is the ELINDER project (European Learning Initiatives for Nuclear Decommissioning and Environmental Remediation) which contributes to the development, coordination and promotion of education and training programmes in nuclear decommissioning at EU level.

In the area of nuclear safeguards and non-proliferation, a flagship example of a JRC training activity is the annual ESARDA course. The European nuclear security training centre, EUSECTRA, inaugurated in 2013 under the EU CBRN Action Plan, has provided training in nuclear safeguards to European and IAEA inspectors and to more than 2000 customs and law enforcement officers, in support to Member States and third countries in the field of nuclear security.

Since the 6th Framework Programme (2002-2006), the JRC had opened its research infrastructure to external users. In the frame of the project EUFRAT, the JRC laboratories can be used for investigating nuclear data through neutron induced nuclear reactions and accurate measurements of radioactivity. The project, ACTUSLAB opens the JRC facilities to granted projects for exploring the science of the actinide elements, preparing nuclear samples and characterising them to understand and predict their chemical and physical properties and behaviour.

Recently, to increase the impact of these initiatives, the JRC reached an agreement with DG for Research and Innovation to financially support the external users through the indirect actions of the Euratom programme. Other JRC labs on materials research and the hot-lab were included to have wider scope of activities.

8.4. Resource allocation by Commission priority

The JRC cost structure is largely fixed. More than 60% of the JRC budget is allocated to staff costs and to the expenses related to the site and scientific infrastructure management (e.g. buildings maintenance, energy, security, scientific equipment, etc.).

In particular, the national regulatory authorities have determined a number of mandatory renovation works.

The licences according to §9 of the German Atomic Law, and according to §3 of the Radioprotection Act, owned by the JRC institute in Karlsruhe (DE), both need to be renewed in order to continue the research activities.

The JRC proposed a specific budget line for infrastructure for the Euratom programme (2014-2018). The renovation of Karlsruhe entrance buildings for personnel and goods were financed from this budget allocation. During the extension period 2019-2020, the budget allocated was reinforced to finance the construction of a new building in Karlsruhe.

During the framework programme period, the resources allocated to Euratom research mainly contributed to two of the Juncker Commission's priorities:

- Priority 3: A resilient Energy Union with a forward-looking climate change policy – Safe and secure use of nuclear energy.
- Priority 9: Europe as a stronger global actor – Global nuclear safety and security

Both contributions interact with each other, the support given to the global nuclear safety and security would not be possible without the research developed in the other area, and vice versa. These two areas of intervention are interdepended one from the other. Notwithstanding, it can be estimated that around 80% of the resources were used in support of the safe and secure use of nuclear energy and 20% were used in support of the global dimension of the nuclear safety and security.

The COVID-19 pandemic: response and impact

9.1. Re-prioritisation of activities

In the early onset of the COVID-19 crisis, the JRC set up a task force to provide a multi-disciplinary response to the crisis. This ensured a level of knowledge management across the many Committees, bodies and discussion groups set up in the Commission and with Member States. The JRC was rapidly involved and able to adapt its work programme to include support to both managing the crisis as well as supporting exit and recovery strategies.

The JRC provided support on a range of issues and disciplines, with 6 priority areas: (i) epidemiological monitoring, modelling and reporting, (ii) use of alternative data and digital technologies, (iii) testing, genomics, diagnostics and health, (iv) socio-economic modelling and analysis, (v) travel, tourism and transport and (vi) take citizen pulse (to better understand how the media and citizens are reacting to issues and policy developments on an emotional level).

The JRC provided evidence for guidelines, communication and working documents of the European Commission aimed at managing the crisis, formulating the exit strategy and designing the recovery plan.

The 2019-2020 work programme underwent a significant update in spring 2020 to accommodate the new emerging work in relation to the COVID outbreak. Six new projects were created, under which 19 work packages were planned, with a total HR effort of 33.5 FTEs.

The human resources were allocated to the new activities following an internal re-prioritisation involving several JRC Directorates.

The budget figures of the work programme were also updated to accommodate the new activities: expenditure worth of 1.2 million EUR was planned 2020 for the COVID-related projects.

In terms of impact (documented use of JRC outputs in policymaking), COVID-19 related work contributed 6% of the total in 2020. Examples of JRC work on COVID-19 are listed below.

- Early detection, monitoring and continuous scientific and technical support with the Epidemic Intelligence from Open Sources (EIOS) platform.
- Control material for Coronavirus testing to enhance the quality of national tests; RNA sequence repository for COVID-19; public database for COVID-19 *in vitro* diagnostic devices and test methods.
- Daily media and misinformation analysis.

- Scenario analysis of the evolution of the crisis, toolbox of measures and good practices to be recommended to the Member States.
- Analysis of mobility data (from mobile phone operators) to provide insights and indicators on the spread of the pandemic, but also on the scope and effectiveness of confinement measures.
- Development of Re-open EU – a web platform launched on 15 June 2020 to safely resume free movement and tourism in the EU.
- Analysis of impact of COVID-19 on the labour market and sector-specific analysis on education, tourism, transport, creative industries, and High Growth Enterprises; COVID-19 impact on telework in Europe.
- Evidence with regard to post-COVID measures, particularly risk assessment; territorial analysis.

> The COVID-19 has created a three-fold challenge to the JRC:
>
> - use required competences to provide policy advice, in an environment of high uncertainty, complex issues and rapid developments
> - make evidence heard when beliefs and claims were often propagated faster than facts and where disinformation has been a daily challenge
> - carry out work under the restrictions on access to laboratories and in situ cooperation.

9.2. Access to laboratories and training

The access restrictions to JRC sites were three-fold:

Limited access of JRC staff to research infrastructures

During the first lockdown phase (approximately between March – June 2020, depending also on the national restrictions in the different JRC sites) the access of staff to the research infrastructures on the different JRC sites was impossible. Because of its heavy dependence on laboratories, the Euratom programme was affected more than the non-nuclear programme. After the summer break, the access was gradually restored and the work in the laboratories could progressively continue. The temporary limitations caused delays in the release dates of publications, on deliverables related to the use of our laboratories and in delivering access (remote) to external users.

Prioritised activities were those related to COVID-19, work under mandate/contract, and work supporting the Commission Work Programme.

Limited access of external users to JRC research infrastructures under the open access programme

In a survey addressed to staff working in the laboratories involved in the open-access programme, 70% reported that they had been affected by more than 90% in their productivity and operational capabilities. Only 20% of the respondents reported that they had been affected by less than 50%.

As the situation gradually improved, alternative ways of communication and operation were introduced. As the open

access programme has also a strong training/capacity building component, e-learning courses and remote trainings were developed and carried out remotely. These efforts paid off, in terms of participation and future use of e-learning.

Supply of materials

During the first lockdown phase where many of the non-essential activities were also halted in the hosting countries, the delivery of consumables and material, as well as the maintenance of the laboratories was also affected. In most cases, however did not add a further delay in the work of the laboratories, as this period also coincided with the restrictions of staff accessing the different JRC sites.

9.3. Impact of COVID-19 on Euratom research activities

Given the restrictions imposed, the laboratory time has been allocated according to 3 different priorities.

1. Safety relevant tasks (including infrastructure interventions) necessary to maintain full compliance with the nuclear licence requirements.
2. Selected scientific projects in which a contractual commitment existed. Among these, high priority was given to the production of radioisotopes for medical treatments. Other examples are the completion of the fuels and fuel capsules for irradiation, the proficiency testing exercise 'Radon in water' the production of reference materials for safeguards or the support provided to safeguards inspectors, including the remote assistance when needed;
3. Other projects that allow for more flexibility on time delays.

Despite the prioritisation of scientific activities, the restrictions have resulted in significant delays for nearly all laboratory activities and only a fraction of the deliverables and outputs planned could be accomplished.

Open access to infrastructure was heavily impacted, as users could not be given access to the sites. Some partial solutions were found (remote monitoring of experiments) or where sufficient staff and access was possible, experiments were carried out by JRC on behalf of collaboration partners whose laboratories were closed due to the COVID-related access restrictions.

The activities of the **Euratom safeguards laboratories** in La Hague (FR) and Sellafield (UK; until end of December 2020) continued nearly uninterrupted to ensure safeguarding of large flows of nuclear materials even under the demanding conditions caused by the COVID-19 pandemic. A special attention was given to the hand-over of the Sellafield laboratories which was performed successfully and in time.

In the context of the pandemic, nuclear power plants and regulatory bodies have taken measures to mitigate COVID-19 pandemic consequences. JRC delivered reports which analysed:

- continued safe operation of nuclear power plants during the COVID-19 pandemic,
- opportunities arising from the 2020 pandemic response.

Output and impact of JRC activities in 2014-2020

10.1. Policy-support output and impact

The JRC registers systematically all outputs from its work programmes and the impact generated on policymaking.

In 2014-2020, the JRC recorded nearly 10 000 policy-support **outputs**, resulting from the JRC work programmes. The majority of these outputs were scientific studies on policy-relevant topics and technical reports on JRC's research and services (66%), followed by scientific information systems and databases (9%), contributions to specific policy documents such as guidelines, regulations or decisions (8%), and training activities (6%), as shown in Figure 13.

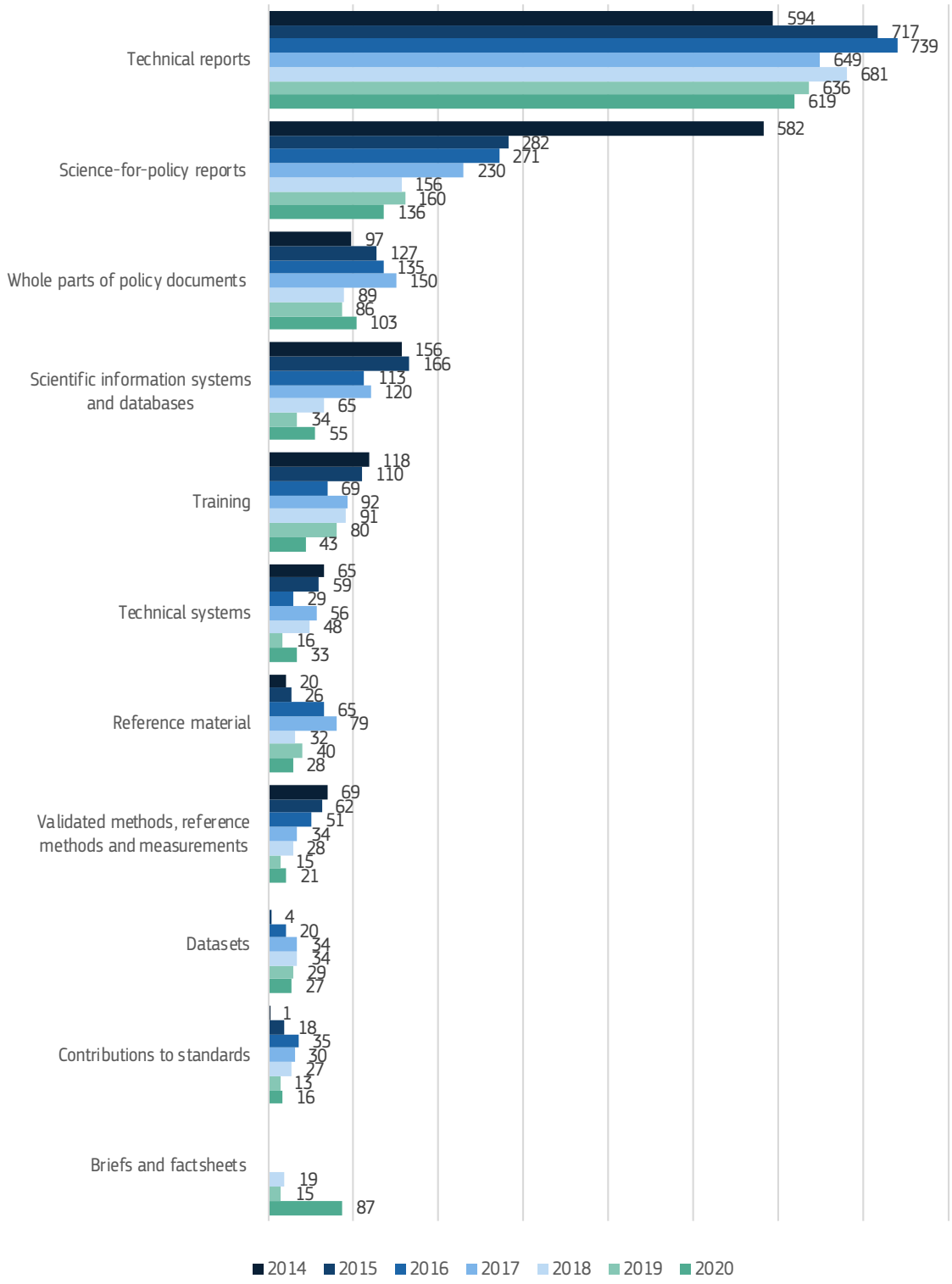


Figure 13. JRC's policy-support outputs by category (2014-2020). The category 'Briefs and factsheets' was introduced from 2018.

To record the short-to-medium term **impact**, units across the JRC report instances of how the JRC's outputs have been used by other European Commission DGs and beyond. Such reports describe the observed impact detailing how JRC's contribution led to it.

The analysis of these outcomes provides insights into which JRC's activities had what impact on the policy cycle and how the impact is distributed over political priorities, the policymaking cycle, and EU-institutional, national, international or private bodies[22].

> Over 2800 policy-impacts were recorded between 2014 and 2020

The number of recorded cases has increased since the 7th framework programme, when this system was set up (Figure 14). The highest number of impacts, 551 was recorded in 2020; this may be accounted for by a strong support to COVID-19 crisis management and response, completion of new activities started as a result of 2030 Strategy and the uptake in the policy process such as foresight and social sciences, and increased support to Member State monitoring (European Semester Country Reports, assessments of the final national energy and climate plans, and contributing to the Commission recommendations of national common agricultural policy strategic plans).

Around 70% of the JRC's policy-impact is linked to implementing and monitoring EU policies and, depending on the number of items on the political agenda, 20-30% to policy preparation. Most of the impacts, 92% and similarly to the value at the end of the 7th framework programme, have benefited another Commission department or the European External Action Service (EEAS), confirming a tight link of JRC work with EU policies;

The re-prioritisation is reflected in the increasing support to the Secretariat-General responsible for overall coherence of the Commission's working methods and policies, to DGs Employment (socio-economics) and Internal Market, and the decreasing support to DG Environment. (Figure 15, see also section 7.3).

As impacts can be linked to multiple beneficiaries, 25% can be traced also to international initiatives where the JRC participates or chairs working groups related to international standards and harmonisation within UN agencies, the OECD, and ISO. Another 20% of impacts largely focus on supporting Member States and Candidate Countries' authorities for environmental protection, nuclear safety and border security, among other areas. In terms of contribution to European Commission's political priorities there is a strong correlation with staff resources (see Section 7.3).

[22] Examples are available in other sections and in the latest annual productivity and impact evaluation report provided to the Panel.

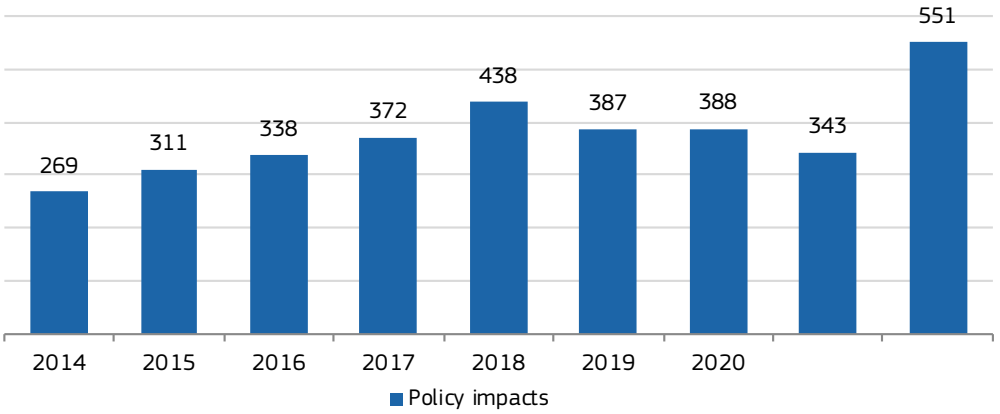


Figure 14. Evolution of the number of policy impacts 2012-2020.

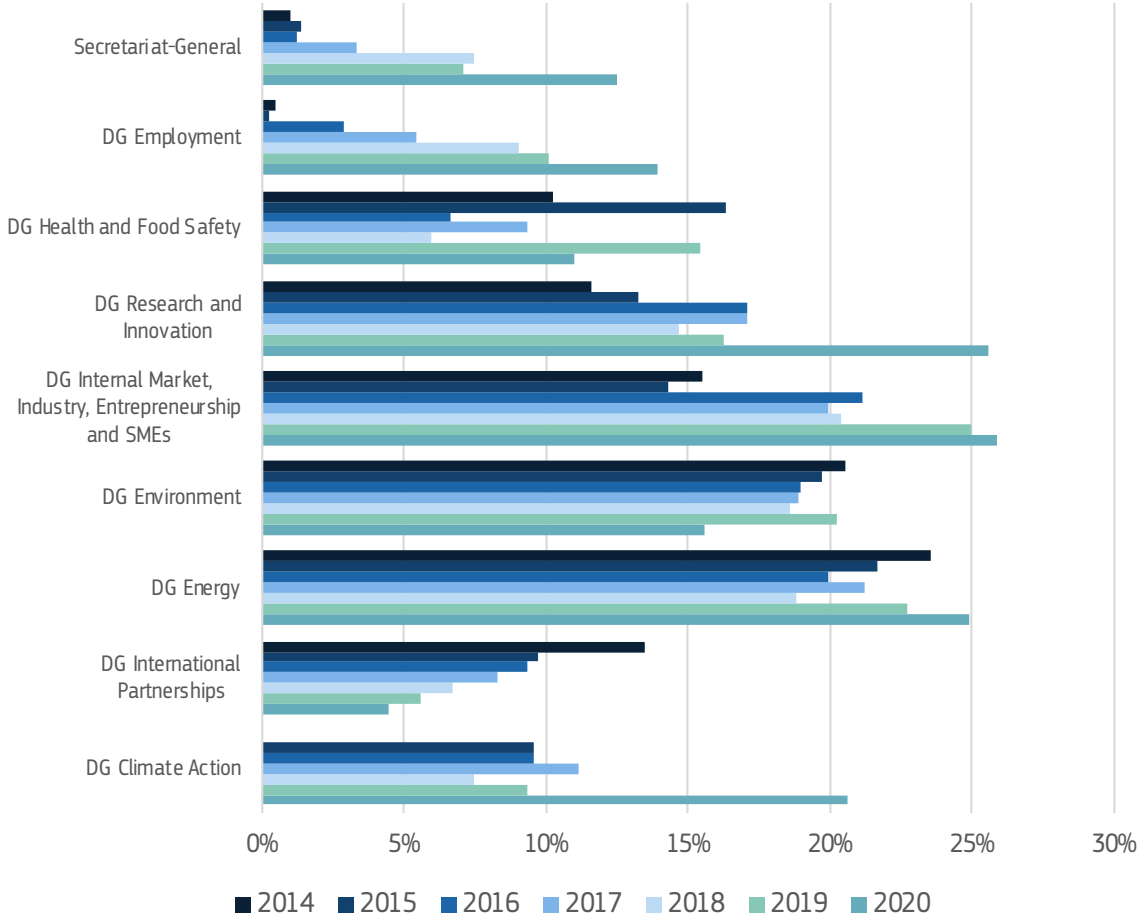


Figure 15. Top 10 Commission departments using JRC's products and services, according to policy-impact analysis (proportion of reported policy-impacts). Values for DG Research & Innovation contain also participation in EU funded research projects which are not assigned to a specific policy area.

Analysis of peer-reviewed publications

Between 2014 and 2020, the JRC's scientists published around 8 000 peer-reviewed scholarly publications including articles (72% of the total), conference papers (14%), book chapters (5%) and reviews (5%). The wider research community is recognising this scientific work, as shown by the commonly used citation impact metrics. The JRC-authored publications, weighted according to

scientific fields, have been cited 2.3 times above the world average (field weighted citation index). 4.7% of them are among the top 1% most-cited publications in the world and 27% are among the top 10%. 6.1% of JRC papers are published in the top 1% and 44% in the top 10% most-cited journals (Figure 16).

The scientific impact of JRC publications, as measured some of the main bibliometric indicators, puts it on par with leading universities and the prestigious research organisations as shown in Table 4.

> Around 8000 peer-reviewed publications of which 44% in the top 10% most-cited journals and 6% in the top 1%

The JRC is a global actor and a partner to both academic community and industry. The wide network of collaborators is reflected in that approximately 80% of all publications are authored with external collaborators and more than 20% include authors from outside the European Research Area (ERA) demonstrating JRC's global connections. In addition, almost more than 7% of publications have been co-authored with industry. This compares well with research and technology organisations conducting industry-relevant research in addition to its support to policy and the scientific community.

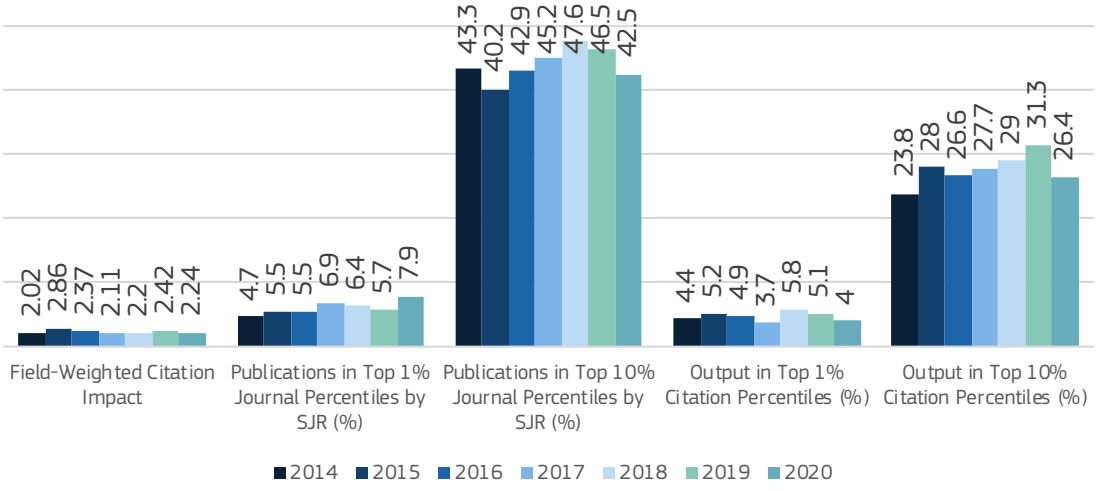


Figure 16. Overview of the main bibliometric indicators for the JRC. Data have been extracted on 21/10/2021

Table 4. Research metrics of the JRC and the comparators for 2014-2020. Data retrieved 21 October 2021.

Entity	Publications	Field-weighted Citation Impact	Output in Top 1% Citation Percentiles (%)	Output in Top 10% Citation Percentiles (%)	Publications in Top 1% Journal Percentiles by SJR (%)	Publications in Top 10% Journal Percentiles by SJR (%)
International Institute for Applied Systems Analysis	2463	2.74	7.9	38	14.6	59.4
Joint Research Centre	8019	2.32	4.7	27.4	6.1	44
University of Oxford (UK)	107781	2.32	4.2	24.1	9.8	52.4
University of Cambridge (UK)	86611	2.16	4.4	25.8	9.7	52.7
Argonne National Laboratory (US)	18742	2.05	5.2	28.2	10.5	61.1
Max Planck Society (DE)	94178	1.93	4.3	28	8.9	53.3
CSIRO (AU)	26952	1.86	3.4	23.6	6.8	48
Oak Ridge National Laboratory (US)	21448	1.74	3.8	23.5	8.5	54.6
Austrian Institute of Technology	3576	1.6	1.7	13.2	2.1	27.5
CEA (FR)	49869	1.56	2.6	19.4	5.5	45.3
INRAE (FR)	52964	1.56	2.4	21	4.9	48.4
United States Environmental Protection Agency	7566	1.56	2.8	23	3.9	43.8
National Institute of Standards and Technology (US)	15664	1.52	2.9	18.4	6.5	46.4

Netherlands Organisation for Applied Scientific Research	6453	1.47	1.6	15.4	3.9	39.7
RIKEN (JP)	24907	1.44	3.1	21.1	6.4	51
National Research Council of Italy	77776	1.4	1.7	18.2	3.7	37.9
VTT Technical Research Centre of Finland Ltd.	6118	1.4	1.5	13.9	2.8	34.2
Chinese Academy of Sciences	373969	1.37	2.9	20.7	4.7	38.2
CNRS (FR)	338646	1.36	1.9	16.9	4.9	42.5
Fraunhofer Society (DE)	31982	1.28	1.1	10.1	2.8	28.4
National Physical Laboratory (UK)	3259	1.14	1.4	13.2	3.4	34.2

The number of publications in journals provide additional evidence for the portfolio shifts in the JRC. The publications related to 'Social sciences' and 'Economics, econometrics and finance' increased 25% and 22%, respectively in 2016-2020 compared with 2014-2018. At the same time, many of those related to physical sciences fell. Furthermore, the greatest increase in citation impact between the two studies was observed on 'Economics, econometrics and finance' (up 13%), indicating increasing recognition of the JRC in this field.

10.2. Evidence from case studies

In 2021, a new impact evaluation methodology was introduced. It is based on current practice of research impact assessment by tracing impact pathways of activities, adapted to the JRC. 50 case studies describing activities in 2014-2020 were produced and evaluated against 11 criteria by experts from academia, businesses, NGOs and national administrations[23, 24]. This sample of case studies represents 20% of JRC human resources allocated to the work programme projects and 10% of the JRC budget[25]. It covers a wide array of different types of activities, distributed proportionally across the Commission priorities and covering the main policy areas to which JRC contributes: health, consumer protection, energy, transport, climate change, socio-economics, environment, agriculture and the blue economy, safety, security and nuclear safety and security.

Table 5 presents a summary of the results of the experts' assessment. The experts found that the JRC's contribution in 42 (86%) cases was instrumental in **shaping and implementing EU policies,** and a moderate impact was achieved through the other 7 activities (14%). They also found that the work described in 36 case studies (73%) influenced policymaking beyond the main stakeholders within the Commission and reached several interest groups and relevant communities at EU and international level and that most of the work (94%) was taken up at EU and international levels.

While impact on policymaking is of primary importance for the JRC, its contributions to **public debate** were judged favourably against a backdrop of dealing with sensitive, confidential or highly technical issues. In 21 cases (41%) the JRC was considered to have reached larger audiences, influencing, informing or shaping perceptions and the level of awareness of the general public as opposed to sectorial stakeholders only. Examples of topics where the JRC's work attracted considerable media attention are the competence frameworks for education including the very popular SELFIE app, the vehicle emissions measurement in particular in the context of the 2015 'Dieselgate' and analyses for the land use and forestry regulation.

The experts also assessed the JRC's contributions to the **scientific knowledge** and concluded for 16 cases (33%) that besides the policy-supporting studies and services, the JRC produced widely cited peer-reviewed work, many of them in top journals in their fields, reaching a diverse range of technical and non-technical audiences.

As regards **long-term societal impacts**, by increasing quality of life and community well-being (e.g. cybersecurity, consumer protection), reducing costs for firms (e.g. fighting fraud), and increasing public awareness about worldwide concerns (e.g.

[23] A dedicated report is provided to the Panel, describing the campaign and the results in more detail

[24] By November 2021, 49 cases have been evaluated by experts

[25] Including all funding sources but spending programmes for decommissioning and nuclear waste management

climate change), the experts considered such impacts could be clearly linked or traced to the JRC actions in 36 cases (73%).

Overall, the experts' assessments together with the feedback collected from the partner DGs (see section 6.3) support the JRC's standing as a competent and effective science and knowledge service.

Table 5. Results of the JRC case studies' assessment by independent experts.

		High impact	Medium impact	Limited impact	
Policymaking	significance	86%	14%		0%
	stakeholder reach	73%	20%	6%	
	territorial reach	94%	6%		0%
Public debate	significance	41%	37%	22%	
	stakeholder reach	41%	39%	20%	
	territorial reach	63%	14%	22%	
Scientific debate	significance	33%	37%	31%	
	stakeholder reach	33%	31%	37%	
Societal impact	significance	73%	16%	10%	
	stakeholder reach	67%	22%	10%	
	territorial reach	84%	10%	6%	

Budget and staff figures: selected trends

11.1. Financial envelope and sources of financing

The JRC's budget, voted by the European Council and the European Parliament, is referred to as its 'institutional budget'. The major part of the JRC's institutional budget comes from the research framework programmes.

For the period 2014-2020 the contribution through Horizon 2020 was EUR 2 845 million of which EUR 855 million is through Euratom. This includes the contributions from the European Free Trade Association (EFTA) countries (EUR 48 million) as well as from Associated Countries (EUR 114 million for Horizon 2020 of which EUR 27 million for Euratom). This is summarised in Table 6.

Table 6. JRC Budget from 2014 to 2020 (round figures, million EUR).

JRC budget 2014-2020	EU voted budget	EFTA contributions	Suppl. credits from Associated countries	Total
Horizon 2020	1 855	48	87	1 990
Euratom	828	-	27	855
Total	2 683	48	114	2 845

In addition to these appropriations, the JRC has received an additional voted budget of EUR 205 million (total for 2014-2020) to carry out activities under the Euratom Treaty for decommissioning of obsolete nuclear facilities. This part of the institutional budget is outside the framework programmes and is not considered in any further detail here.

Using its specific competences, the JRC generates external revenues on top of its institutional budget, e.g. through additional work for Commission services and contract work for third parties, and as a participant in indirect actions of the Framework

Programme by teaming up in consortia and expert networks. During Horizon 2020 the JRC has generated additional income, equivalent to roughly 19% of its institutional budget (Figure 17).

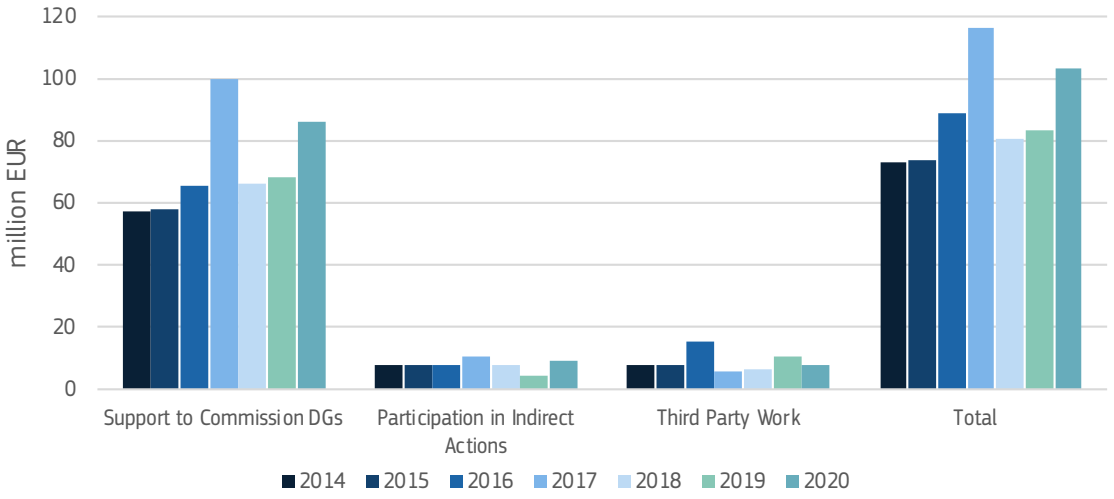


Figure 17. Trends of contractual activities of the JRC.

These contractual activities complement the tasks outlined in the JRC's own work programme and are seen as an essential tool for acquiring and transferring expertise and offering some of its unique experience. They also integrate the JRC in the European research landscape and in building strong partnerships with policy DGs within the Commission.

The JRC Framework Programme Budget to be executed during 2014-2020

Table 7, Table 8 and Table 9 present the evolution of the JRC's Horizon 2020 budget from 2014-2020 divided into three main categories:

- staff expenses for permanent and non-permanent personnel (roughly 60% of the total),
- means of execution, e.g. expenses for maintenance of buildings and equipment, electricity, insurances, consumables, and for major infrastructure projects;
- operational expenses, i.e. expenses for scientific work, e.g. lab equipment, consumables.

Table 7. JRC EC - Horizon 2020 Framework Programme budget (round figures, million EUR).

H2020 programme	2014	2015	2016	2017	2018	2019	2020	Total
Staff expenses	169	169	171	173	173	179	182	**1 215**
Means of execution	60	60	60	60	60	62	63	**426**
Operational expenses	34	24	26	27	27	38	39	**214**
Total	**263**	**253**	**256**	**260**	**261**	**279**	**283**	1 855

Table 8. JRC Euratom – Horizon 2020 Framework Programme budget (round figures, million EUR).

Euratom programme	2014	2015	2016	2017	2018	2019	2020	Total
Staff expenses	64	64	64	64	64	66	67	**454**
Means of execution	37	37	37	37	37	52	57	**295**
Operational expenses	10	11	11	11	11	12	13	**78**
Total	**112**	**112**	**112**	**112**	**112**	**130**	**139**	**828**

Table 9. JRC Horizon 2020 (EC & Euratom) Framework Programme budget (round figures, million EUR).

H2020 + Euratom programmes	2014	2015	2016	2017	2018	2019	2020	Total
Staff expenses	233	233	235	237	237	244	252	**1 669**
Means of execution	97	97	97	97	97	114	120	**721**
Operational expenses	44	35	36	38	38	50	52	**292**
Total	**375**	**365**	**368**	**372**	**373**	**409**	**421**	**2 683**

Additional external income

The JRC generates additional income through work under contractual arrangement. Table 10 shows the value of contracts signed and inscribed from 2014 to 2020 for the three types of contracts:

- JRC's participation in indirect actions;
- direct support to Commission services outside the Framework Programme,
- work for third parties such as industry or regional authorities.

Table 10. Additional external income during the last 7 years (million EUR).

Contracts signed	2014	2015	2016	2017	2018	2019	2020	Total
Indirect Actions	8	8	8	11	8	4	9	55
Support to Commission services outside the FP	57	58	66	100	66	69	86	501
Third Party Work	8	8	15	6	6	11	8	62
Total (contracts signed)	73	74	89	117	80	83	103	619
Cashed income from contractual activities	70	70	89	87	81	79	85	561
Contractual income indicator	19%	19%	24%	23%	22%	19%	19%	

Comparison with FP7 budget

Figure 18 presents the JRC voted budget for the financial programming period (Horizon 2020, 2014-2020) in comparison with the previous one (FP7, 2007-2013), including the non-nuclear and nuclear programmes. The Horizon 2020 budget represents a reduction of 6.1% with respect to FP7 when considering a 2% nominal inflation (largely linked to staff expenses).

It reflects a budgetary reduction for the JRC in accordance with the decision on Horizon 2020, taken in December 2013, amended during the subsequent yearly budgetary procedures and modified in 2015 by the Commission initiative to launch the European Fund for Strategic Investment (EFSI). The latter represents a cut of EUR 46 million of non-nuclear scientific credits in 2015-2018.

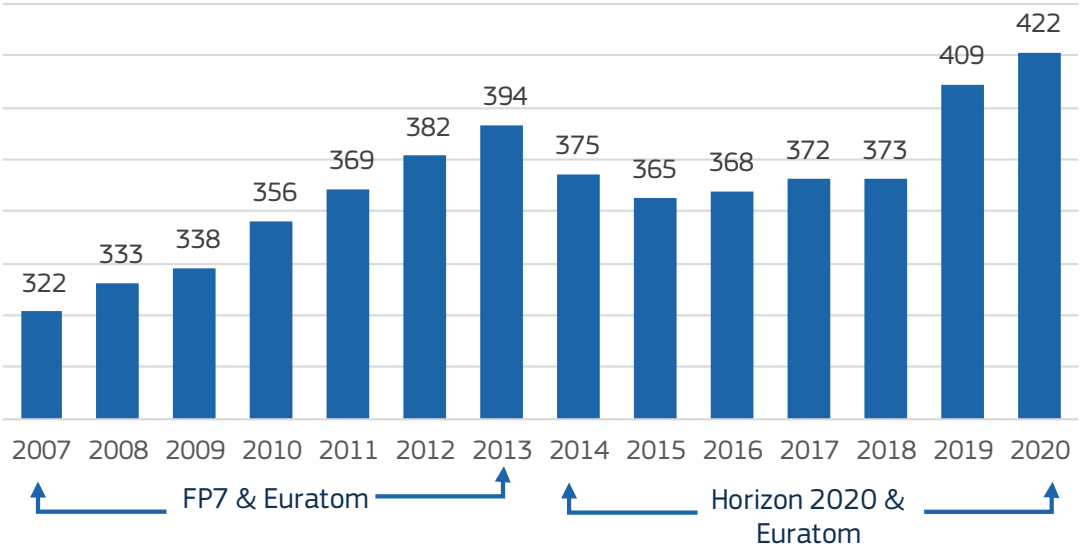


Figure 18. Voted JRC budget in FP7 and Horizon 2020 expressed in million euros.

11.2. Human resources

Development of number of staff

Figure 19 displays the evolution of the number of permanent and temporary staff over the period 2014-2020. Figure 20 shows the distribution of staff in the six sites of the JRC, during the same period.

The multiannual financial framework (MFF) 2014-2020 took account of the cost savings and efficiency gains demanded from all public administrations. This resulted in a 4% staff reduction of permanent staff across the European Commission over 7 years (2014-2020).

Accordingly, the number of JRC permanent staff (nuclear and non-nuclear) was reduced annually by 1% as from 2013. The redeployment exercise of permanent posts across all Commission departments was translated into a further reduction of total staff by 9% for the JRC in the period for 2014-2020. The number of JRC's permanent posts has been reduced by 183 in the same period for which JRC was able to use vacant positions and those occupied by staff who retired. The number of temporary posts has not been cut in the same proportion, but being linked to the resources available to finance them, has resulted in a loss of posts of 5%. The reduction of staff from 2017 to 2018 is explained by the move of staff to the central account management centres (44 permanent positions and 28 temporary positions).

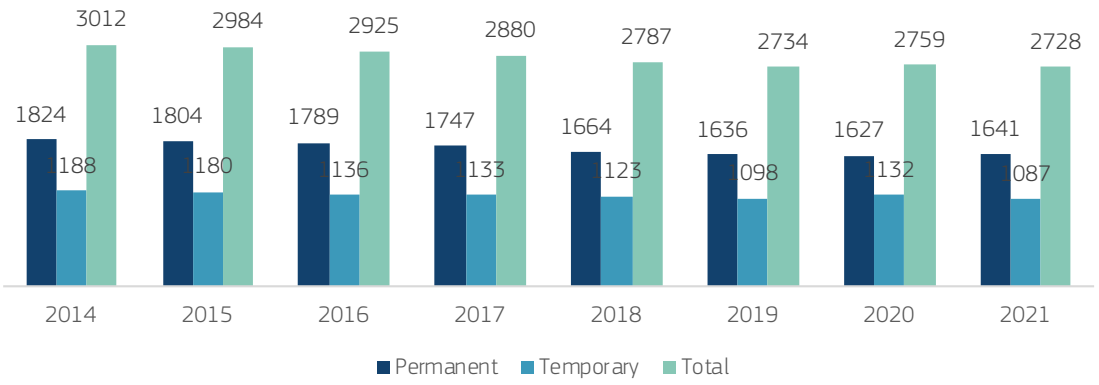


Figure 19. Evolution of the JRC staff number (staff present on 1st January of each year)

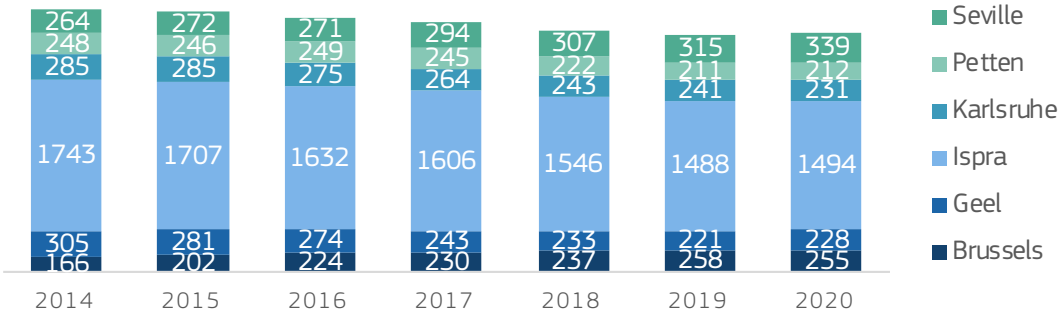


Figure 20. Staff distribution by JRC site over the period 2014 - 2020

The reorganisation in 2016 introduced a shift in the relative importance of portfolios, resulting in an increase of the overall number of staff in Seville, continued increase in Brussels and continued decrease in other sites.

Administrative staff vs scientific and research staff

JRC monitors the ratio of administrative support and coordination staff to scientific and research staff. This ratio was close to 40 to 60 in 2014, by the end of 2016, the JRC reduced the ratio to almost 35:65, reaching in 2017 the target of 30:70 (Figure 21).

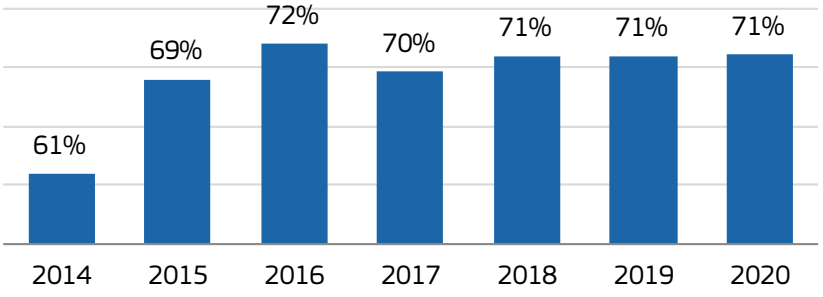


Figure 21. Scientific and technical staff in the JRC. The rounding up to 100% is the administrative staff

Gender balance

There are several drivers for improving the gender balance across the hierarchy and types of positions, chief among which the Commission policy and imposed targets, supported by a recommendation for the JRC during the last ex post evaluation. As a result:

- The JRC is gradually employing more women on permanent posts, with slight increase in the gender balance, somehow counterbalanced by a decrease on temporary posts. This leaves the overall gender balance almost unchanged (Figure 22).

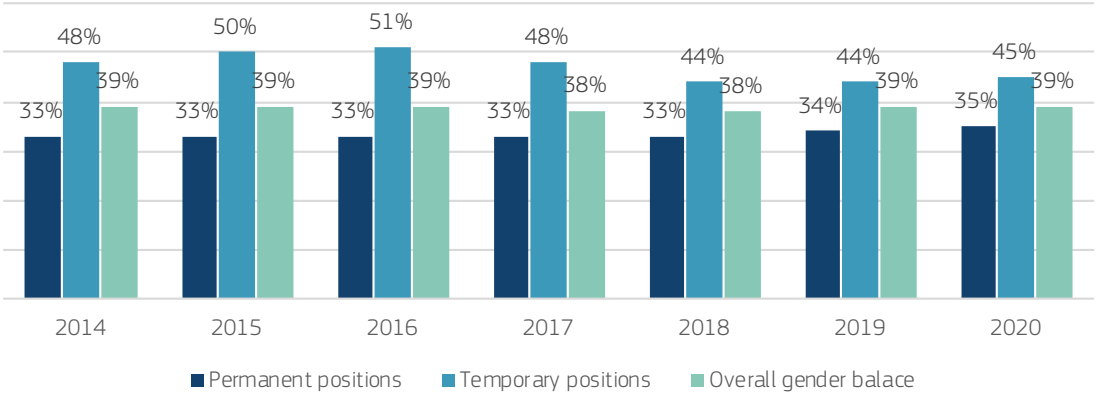


Figure 22. Female staff members broken down by permanent and temporary staff, over the period 2014-2020.

- There is an increasing proportion of women in middle management, supported by dedicated actions and mandatory targets, as well as in deputy head of unit positions.

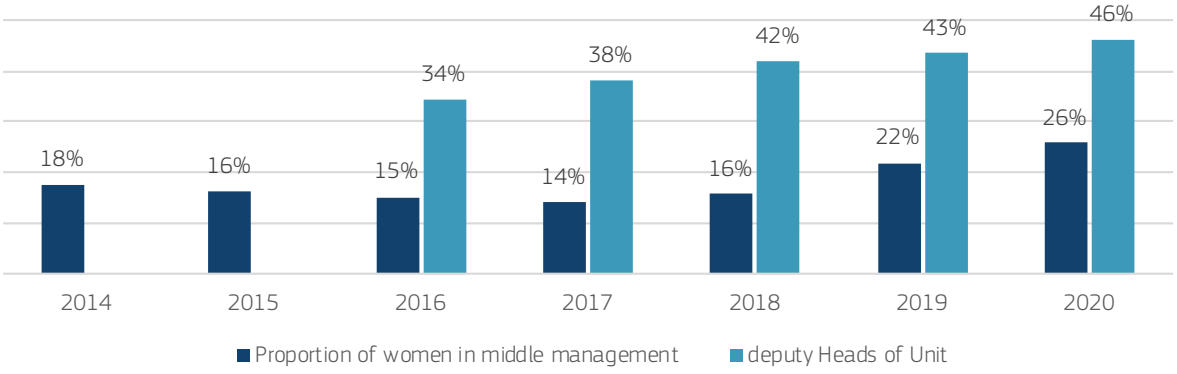
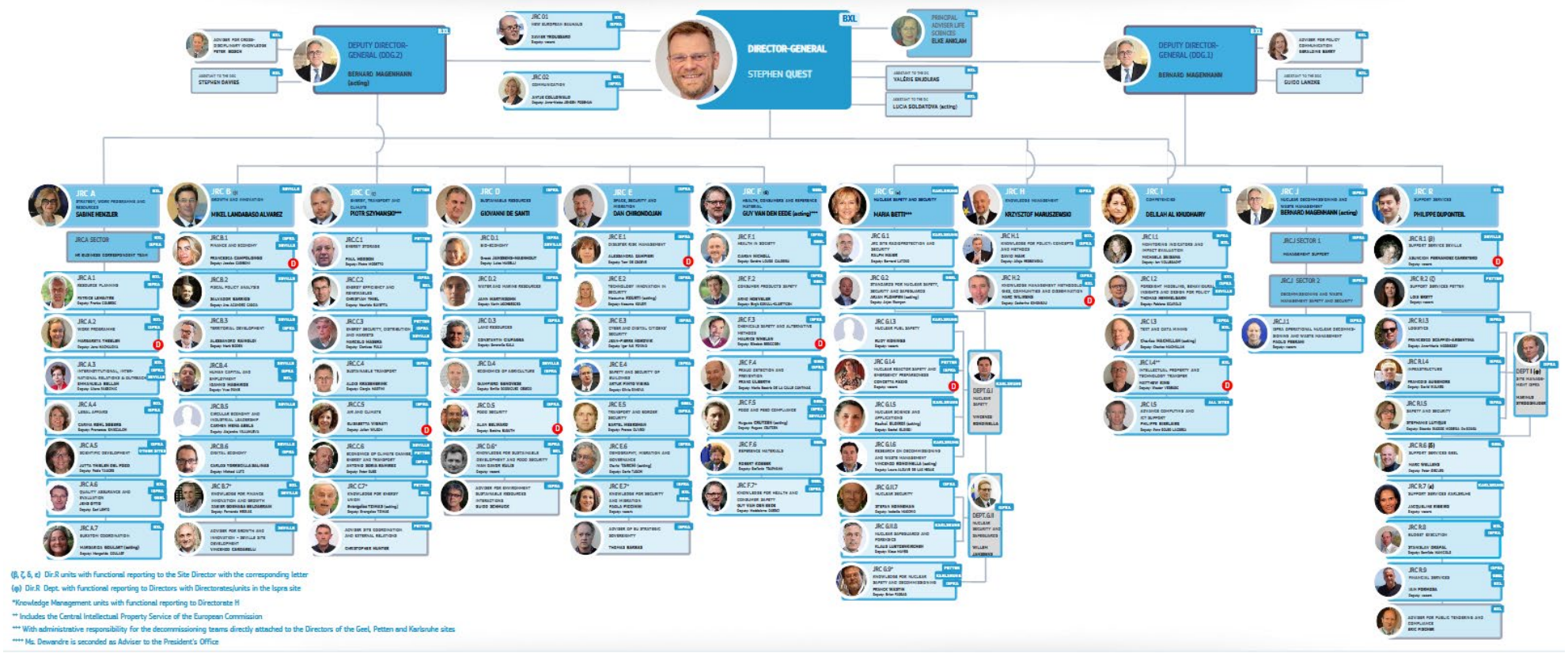


Figure 23. Trends for woman occupying middle management and deputy Heads of Unit positions (dHoU). dHoU positions have been introduced in 2016, hence no data are available for 2014 and 2015.

Annexes

to the Facts and Figures

Annex 1 – Organigramme



Annex 2 – Intervention logic

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

LEGAL MANDATES

Horizon 2020 & Euratom Treaty establishing a joint nuclear research centre

SCOPE

Covering all key policy areas; Cross-cutting support through policy nexus

INDICATORS

Output: policy support productivity indicators; scientific productivity indicators

Results: policy-impact indicator; scientific impact indicators; completed vs planned deliverables; partner/stakeholder satisfaction

Impact: measurable through evaluations of EU policies

NEEDS

Societal challenges; Research needs defined together with Commission's policy departments

OBJECTIVES

H2020; Euratom; Commission general objectives; Specific objectives defined by policy area

INPUTS

Budget m€ 350 under framework programmes for research & contracts; Ca.3000 staff of which over 2000 in scientific/technical functions

ACTIVITIES

Creating, managing and making sense of knowledge;Anticipating emerging issues; Operational services for EU (e.g. crisis management, reference laboratories, bureaus, data centres)

OUTPUTS

Study reports, data, technical systems, standards & services

RESULTS (OUTCOMES)

Incorporation of scientific and technical knowledge into policy proposals or related to the support of the implementation of EU policies

IMPACT

Long-term, indirect socio-economic impacts through better policies

An updated version is here

Annex 3 – Activities phased out

European Union Reference Laboratories. During the past decade, the JRC has run six European Union Reference Laboratories (EURLs) in the area of food and feed safety that are under legislation managed by DG Health and Food Safety (SANTE). Following a thorough analysis of JRC's involvement and the technical maturity in the Member States, the JRC decided to hand over three EURLs to the Member States. The concerned EURLs are the EURL on heavy metals, the EURL on mycotoxins and the EURL on polycyclic aromatic hydrocarbons. After 2017, JRC has supported a smooth handover to those Member States' organisations that were be selected by DG SANTE. The other three EURLs (GMOs, feed additives and food contact materials) are politically sensitive and therefore the JRC will continue running them.

The **Forest Information System for Europe** (FISE) is the hub for data and information on forests and forestry in Europe. Its development followed the EU Forest Strategy in the European Commission Communication of September 2013 (COM (2013) 659 final), which calls for strengthening the forest knowledge base to better understand the complex environmental and societal challenges that the forest sector faces. The JRC agreed with ENV that, following the development of a prototype, it would be transferred to the EEA (2019).

Activities related to **hydrogen as an energy carrier in transport** were either closed down (eg assessing the potential of advanced hydrogen storage in materials; assessment of safety hydrogen detectors; general modelling of hydrogen safety) or re-shaped (safety of hydrogen storage tanks evolved into safety of re-use of natural gas pipelines for hydrogen transmission).

Activities related to noise were phased out after the revision of the **Environmental Noise** Directive (2015) which the JRC supported. .

In response to various directives on transport safety, the JRC had developed a **common platform for reporting and sharing accident information** (rail, aviation, maritime), partly in cooperation with the relevant agencies. Operated since about 2011 by the JRC, these were handed over to agencies (European Railways Agency (ERA, established in 2016), European Union Aviation Safety Agency (EASA, established in 2002), European Maritime Safety Agency (EMSA, established in 2002). In addition, JRC is preparing the hand-over of the **Common Information Sharing Environment** (CISE) to EMSA. CISE is an EU initiative that aims to make European and EU/EEA Member States surveillance systems interoperable. The JRC was central in developing CISE, which started more than 10 years ago. These are examples of (pre)operational work (development), which was not financed by institutional work and which was aimed to be handed over once the system is operational (transitional period to 2023).

Genetically modified organisms (GMOs) related bureaus. After the Commission proposal to allow Member States to opt-out for the use of GMOs crops in part of their territory for reasons other than risk assessment, it was considered that running the European Coexistence Bureau (ECoB) and the European GMO Socio-Economic Bureau (ESEB) was no longer a strategic priority. Therefore, ESEB activities concluded in 2015 and ECoB activities concluded in 2016. The EURL on GMOs was maintained (see above).

A cyclotron facility was shut down in 2014, due to continued re-prioritisation of JRC activities to more directly policy relevant ones, and due to the existence of cyclotron facilities across the EU.

Annex 4 – JRC Strategy 2030 - Objectives

It set out five objectives, for which a series of indicators were developed with yearly monitoring (JRC Strategy 2030 Scorecard). A roadmap for its implementation laid out 46 actions, the last two of which were completed in 2018.

The five objectives of the strategy are:

Objective 1 - The JRC aims to be a *strategic partner at the core of the Commission:* the JRC is positioning itself close to the political heart of the Commission and co-designing its work programme with the policy Directorates-General (DGs) and /or the Member States.

Objective 2 - By building partnerships with the best organisations and retaining its commitment to scientific excellence, the JRC moves towards fulfilling the objective to be a *fully policy-relevant and world class in knowledge generation.*

Objective 3 - With the plethora of data and information inundating the scientific world, the need to digest, review and make sense of all the available relevant information becomes a prerequisite to decision-making. With the objective to be a manager of priority-driven knowledge and competences, the JRC has started to significantly re-design its service provision, facilitated not the least by a major re-organisation in 2016, including through the creation of Knowledge and Competence Centres.

Objective 4 - In support of the internal (JRC and Commission) working methods, there will be an enhanced emphasis on *anticipation*, multi-disciplinarity and *working across organisational and sectoral boundaries* to improve the perception of the JRC as one.

Objective 5 - By aiming to be a *people-centric, leaner and more efficient organisation*, the JRC is focusing on its staff members and offering talent management and leadership development programmes, giving staff opportunities to develop their skills and competences. Long-term development plans for infrastructure, including ICT, aim to ensure that the JRC retains its international recognition and provides a stimulating and modern working environment.

Annex 5 – Training and Education

In view of impact oriented work, the JRC Strategy 2030 sets out a more strategic approach to DG JRC's partnerships with external organisations and its **education and training activities** to enhance JRCs visibility. With the **EU Academy**, a modern, scalable e-learning platform[26] available to all EU Institutions is being developed with the objective to host, manage and monitor pedagogical content developed by the EU Institutions themselves and/or their trusted partner organisations. In 2019 a review on learning platforms showed that instead of having more than 25 EC services offering training platforms to external professionals, it would be advantageous to join forces and build a single e-learning platform that all could share. Pooling resources is expected to lead to synergies and significant efficiencies savings, and importantly, **provide EU citizens with a one stop shop for training content** at the science-policy and policy-society interfaces. DGs CNECT, COMM, DIGIT, EAC, ESTAT, HR, INTPA are part of the EU Academy Steering board. The pilot platform was launched in autumn 2020 with 10 courses and by end of 2020 the platform had more than 2000 users, a figure that doubled by June 2021.

Annex 6 – Communication initiatives and Writing with Impact

Key figures on Communication initiatives

Between 2017 and 2020, the JRC published **over 100 news items per year** on its website, the Science Hub (Figure 24). Special attention has been given to writing for news impact, evidenced by an **increase in mentions of JRC work in the media.**

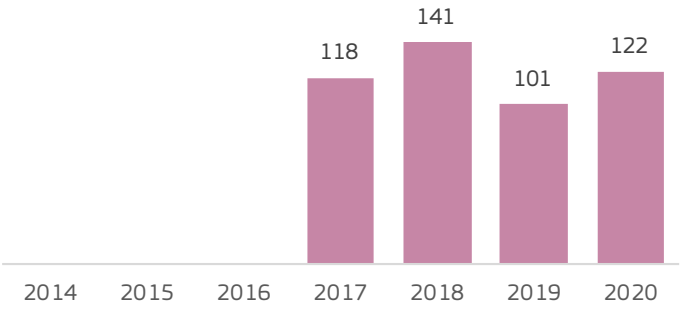


Figure 24. News published on JRC Science HUB - Between 2017 and 2020.

[26] https://academy.europa.eu/

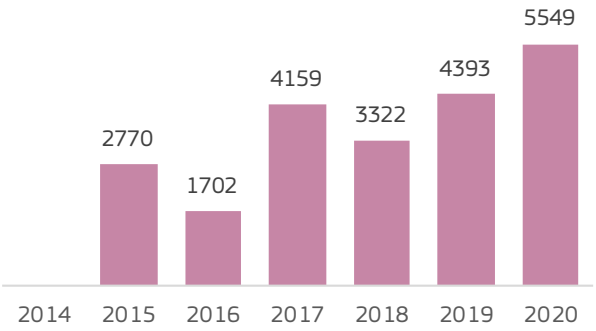


Figure 25. Number of articles in press referring to the JRC.

The JRC **social media visibility** has increased significantly since 2014 on all our four main platforms (Facebook, Twitter, LinkedIn and YouTube).

Table 11. Growth of the visibility of the JRC on the main social media platforms expressed by the number of followers.

FOLLOWERS	2014	2015	2016	2017	2018	2019	2020
Twitter	875	2888	9886	17000	26000	36600	48372
Facebook	/	620	4498	8786	14170	19850	23064
LinkedIn	7000	10320	15841	21808	30580	49180	54998
YouTube	233	339	665	1116	1680	2380	3320

The EU Science Hub has been reinforced in terms of digital recognition and mentions online. Of all the EU social media accounts listed within the European Research & Innovation realm, the JRC has the fastest growing social media presences.

Between 2014 and 2020 (before the COVID-19 closures), the press team organised **three press visits to the JRC per year**, two linked to the EU presidency, and one thematic, e.g. food fraud. The press team also organised training courses for journalists, on the use of the JRC's data tools.

In 2020, JRC contributed substantially to the Commission's work against COVID-19 including a new JRC COVID Task Force and linked communication actions for its various clusters.

In order to improve the quality of policy briefs, science for policy reports and other strategic JRC documents that target policymakers, citizens and stakeholders, the **JRC Clear Writers' network** was launched as a pilot in 2017, developing templates, tools, tips and targeted training courses, e.g. on 'translating science', executive summaries, leaflets, speechwriting, briefings and journalistic skills. More than 300 JRC staff have followed the network training at multiple sites, improving skill set of staff, and regularly view documents, templates and tool box. The activity has also been proposed for several awards and won the JRC 2019 Excellence award for team work.

Annex 7 - List of Flagship Reports

Title	Release date
Artificial Intelligence - A European perspective	December 2018
China - Challenges and prospects from an industrial and innovation powerhouse	May 2019
Demographic scenarios for the EU - Migration, population, education	June 2019
The future of cities - Opportunities, challenges and the way forward	June 2019
The future of road transport - Implications of an automated, connected, low-carbon and shared mobility	June 2019
Understanding our political nature (former Enlightenment 2.0)	Published on 18 July 2019
Blockchain now and tomorrow - Assessing multi-dimensional impacts of distributed ledger technologies	September 2019
The changing nature of work and skills in the digital age	September 2019
Beyond averages. Fairness in an economy that works for people	June 2020
Cybersecurity. The trust anchor of our digital society. A European perspective	July 2020

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List of abbreviations and definitions

AGRI	Directorate-General agriculture and rural development (EC)
AIT/ARC	Austrian Research Centre (AT)
ANL	Argonne National Laboratory (US)
CAM	University of Cambridge (UK)
CAS	Chinese Academy of Sciences (CN)
CEA	Commissariat à l'énergie atomique et aux énergies alternatives (FR)
CERN	European Organization for Nuclear Research
CNR	Consiglio Nazionale delle Ricerche (IT)
CNRS	Centre National de la Recherche Scientifique (FR)
COMM	Directorate-General Communication (EC)
CSIRO	Commonwealth Scientific & Industrial Research Organisation (AU)
DG	Directorate-General of the European Commission (i.e. department)
DEVCO / INTPA	Directorate-General International Cooperation and Development (EC) / International Partnership
EC	European Commission
ECoB	European Coexistence Bureau
EEAS	European External Action Service (EU)
EMM	Europe Media Monitor
EMU	Economic and Monetary Union
ENER	Directorate-General Energy (EC)
ENV	Directorate-General Environment (EC)
EP	European Parliament
EPA	Environmental Protection Agency (US)
ESE	European GMO Socio-Economic Bureau
ESTAT	Eurostat (EC)
EU	European Union
EURL	European Union Reference Laboratory
EUSDR	European Union Strategy for the Danube Region
FG	Fraunhofer-Gesellschaft (DE)
GROW	Directorate-General Internal Market, Industry, Entrepreneurship and SMEs (EC)
IIASA	International Institute for Applied System Analysis
INRA	Institut National de la Recherche Agronomique (FR)
INSPIRE	Infrastructure for Spatial Information in Europe

MPG	Max-Planck-Gesellschaft (DE)
NEAR	Directorate-General Neighbourhood and Enlargement Negotiations (EC)
NIST	National Institute of Standards and Technology (US)
NPL	National Physical Laboratory (UK)
OECD	Organisation for Economic Co-operation and Development
ORNL	Oak Ridge National Laboratory (US)
OX	University of Oxford (UK)
REFIT	European Commission's Regulatory Fitness and Performance Programme
RIKEN	Rikagaku Kenkyusho (Institute of Physical and Chemical Research) (JP)
RSB	Regulatory Scrutiny Board
RTD/R&I	Directorate-General Research and Innovation
RTO	Research and Technology Organisations
SANTE	Directorate-General Health and Food Safety (EC)
TIM	Technology Innovation Monitor
TNO	Netherlands Organisation Applied Science Research (NL)
VTT	VTT Technical Research Centre of Finland (FI)

Annex III

List of affiliations of stakeholders interviewed

European Commission:

- Cabinets of Members of the Commission:
  - Ursula von der Leyen, President
  - Frans Timmermans, Executive Vice-President responsible for the Green Deal
  - Maroš Šefčovič, Vice-President responsible for Interinstitutional Relations and Foresight
  - Dubravka Šuica, Vice-President responsible for Democracy and Demography
  - Mariya Gabriel, Commissioner responsible for Innovation, Research, Culture, Education and Youth
- Directorates-General:
  - Agriculture and Rural Development
  - Climate Action
  - Communications Networks, Content and Technology
  - Energy
  - Financial Stability, Financial Services and Capital Markets Union
  - Health and Food Safety
  - International Partnerships
  - Regional and Urban Policy
  - Secretariat-General (Regulatory Scrutiny Board).

European Parliament:

- European Parliamentary Research Service (EPRS)

Board of Governors, JRC

Annex IV

List of recommendations

Cross-cutting recommendations

The JRC should be involved at an early stage in the priority setting among policy DGs and establish a centralised process for ensuring that the work programme reflects these priorities and the breadth of knowledge needed to support the priorities. This process should also incentivise policy DGs and the JRC to break silos and integrate suitable workstreams.

The JRC should build capacities and tools to prepare for, and respond to, future shocks. To this effect, it should i.a. invest in collecting and maintaining data on past and future shocks.

The JRC should review the indicators for measuring impact, taking into consideration current Commission initiatives on reforming research assessment methodologies.

The JRC should use more holistic approaches in designing its work programme and response to policy needs, and develop, as part of its business model, a strategic plan for integrating social sciences.

The JRC should give anticipation a high priority, as foreseen in the JRC Strategy 2030, allocate sufficient resources and set up a governance structure to optimise the efforts.

The JRC should develop and implement an organisation-wide strategy to drive the collection, integration, utilisation and storage of data, to ensure data quality and regulatory compliance and build data governance capabilities to break data silos.

The JRC should develop a communication strategy to enhance its communication at different levels, customising it to different target groups, and using the most suitable channels (digital or traditional) to reach to such groups.

The JRC should implement a proactive talent acquisition approach at all levels of seniority, with the aim of establishing a more diverse workforce, in particular with regards to gender balance. This applies to external recruitment but also to suitable internal development programmes to incentivise and motivate potential candidates.

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

The Panel encourages the JRC to systematically develop and apply criteria in relation to its unique strengths and policy relevance for deciding whether or not to engage in a particular activity, and for disengaging from it.

Thematic recommendations

The JRC should embed the concept of resilience in all the relevant activities, and develop a more holistic, strategic, and cross-disciplinary approach for assessing and monitoring resilience.

The JRC should consider using the digital-green twin transition as an example and build capacity for problem-based multidisciplinary research for other twins.

The JRC should rethink its research foci in energy, climate and transport, and shift more attention to the demand side, systemic and institutional solutions, perhaps even to consumption and lifestyles, as opposed to just technology and the supply side. It should also address energy challenges in a broader context than just climate change, for example energy poverty and biodiversity loss.

Euratom recommendations

The JRC should study regulatory aspects as well the safety, security and safeguards of small modular reactors.

The JRC should integrate social science research in the Euratom activities, in particular as regards risk assessment, crisis preparedness and response, making use of the approaches to be developed for the JRC as a whole.

The JRC should further embed the concept of resilience and the green and digital transition in the Euratom part of its work programme.

The JRC should strengthen competencies to support spent nuclear fuel disposal activities and develop strategies to capture and share best practices from EU and national projects with all EU Member States.

The JRC should develop foresight activities for nuclear energy, in support of the green transition and for promoting the resilience of the energy system.

The JRC should maintain a strong research programme for nuclear safeguards and non-proliferation.

Concluding recommendations

The JRC should establish an external expert group to advise on strategic development, integration and priority setting of its activities.

The Panel recommends to maintain interviews with stakeholders by the panels in future external evaluations under the framework programmes for research and innovation and the Euratom research and training programmes.

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The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

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