Joint Research Centre

Annual Report 2019

The European Commission's science and knowledge service

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Foreword by Commissioner Mariya Gabriel

We need to make the most of our science and knowledge to kick-start the transition to a fair, climate-neutral and digital Europe and deliver tangible benefits to European citizens, businesses and society. We rely on science, research and education to anticipate and grasp the opportunities that these changes will bring.

The European Union is investing significantly in our young people, our innovators and our researchers to prepare for the transition. We finance world-leading science, research and innovation to help us find European solutions to global issues. And we invest billions of euros to promote the mobility of students, teachers and researchers and cooperation across borders, cultures and disciplines to collectively address the societal challenges we are facing.

We also practice what we preach. In my mandate as Commissioner, I will ensure that research, policy and economic priorities go hand in hand. One way we will go about this is by making the most of the new thematic missions within the future Horizon Europe programme, such as adaptation to climate change and smart cities.

Closer to home, inside the Commission, Commissioners will continue to rely on the Joint Research Centre to support their services across the entire range of EU policies, with research, knowledge, competences and tools to anticipate, prepare for and respond to complex policy challenges.

With over 2 000 scientists working in six sites across the Union, the Joint Research Centre (JRC) covers every EU policy area from agriculture and climate action, through digital and energy, to trade and taxation. The policy support it provides is underpinned by scientific excellence. It is not by chance that, in 2019, six JRC scientists were among the world's most influential researchers, half of them with exceptional broad performance across several fields.

They and their colleagues contributed to a better understanding of our world in various ways during 2019. They provided up-to-date information on greenhouse gas emissions as well as on the expected costs of climate change, and they documented large geographical mismatches between the revenues and tax bills of major digital companies in Europe. They also presented new, evidence-based recommendations for breast cancer healthcare in the EU and conducted a Europe-wide testing campaign in response to concerns about dual food quality.

But science is just science until you bring it to the people who can use it to change the world – such as policymakers, businesses and citizens. In 2019, the JRC did well in these areas, too.

Its six knowledge centres and seven competence centres have provided invaluable expertise and tools to assist policymakers, for example through the *Atlas of Migration* which presents the latest comprehensive data on migration. It also published a series of forward-looking reports compiling the current state of knowledge on topics including the rise of China as a research and innovation superpower, changes in our demographics, and the future of road transport. In order to disseminate its knowledge far and wide, the JRC has also been experimenting with innovative citizen outreach tools. It has brought science closer to national and regional authorities through its 'Science meets Parliaments' and 'Science meets Regions' projects and continued its tradition of bringing artists and scientists together to explore the deeper meaning of tomorrow's challenges.

As a taxpayer-funded governmental research institute, the JRC is also keen to help others for the benefit of scientific progress. It has hosted young scientists from EU Member States, and trained PhD students in how to work with policymakers and, in 2019, it opened 16 more world-class laboratories for use by external scientists who are engaged in societally relevant research.

After a successful 2019, I look forward to the JRC providing its full support to the Commission's political priorities in 2020 and beyond.

Mariya Gabriel

European Commissioner for Innovation, Research, Culture, Education and Youth

Observations from the Board of Governors

The technological, societal, climate, and geopolitical transformations we witness today have profound economic, social and environmental implications. More than ever, effectively addressing these implications requires policies underpinned by robust scientific evidence. In 2019, as in previous years, the JRC fulfilled its science and knowledge functions through analytical, anticipatory and innovative approaches. Working with all Commission services, the JRC supported a wide range of policy priorities to help achieve a more competitive, fair, sustainable and influential Europe.

We, the Board, wish to pay tribute to Director-General Vladimír Šucha, whose leadership, vision and drive were instrumental in achieving the JRC's ambitious objectives and raising its profile within the Commission and beyond. We wish him the best in his endeavours. We also want to thank Deputy Director-General Maive Rute, who moved to a new job in October, and wish her success in her career.

The Board welcomes the election of the new President of the Commission, Dr Ursula von der Leyen, and the ambitious vision she has outlined for the next five years. We congratulate Commissioner-designate for Innovation and Youth, Mariya Gabriel, for taking responsibility for the JRC. The Board notes that strengthening evidence-based policymaking and strategic foresight are now the responsibilities of Vice-President-designate for Interinstitutional Relations, Better Regulation and Foresight, Maroš Šefčovič, whom the JRC will also support. We encourage the JRC to continue working closely with the Vice-Presidents and Commissioners and support them in fulfilling their mandates.

The success of this Commission hinges on anticipating and addressing complex challenges that cut across policies and portfolios: in this endeavour, the JRC's knowledge, competences and tools are essential assets.

The Board appreciates the JRC's efforts to develop its forward-looking capacity, including through Foresight, Horizon Scanning and Modelling. In 2019, the JRC delivered informative flagship reports on emerging multidisciplinary issues of strategic importance for the EU and the world.

The JRC continued to support better regulation with its expertise, including through impact assessment and evaluation methodologies, as well as modelling and data analysis. It has asserted itself as a leading organisation in knowledge management for policies, closely collaborating with Member States and Associated Countries, and showcasing the EU's added value.

Developing a permanent dialogue with citizens is key for the EU to communicate effectively in times of increasing fragmentation and disinformation. The Board welcomes the JRC initiatives to engage citizens on societal and economic issues, including the launch of the new Community of Practice for Citizen Engagement.

The Board notes that the building blocks of the JRC 2030 Strategy are fully defined and already bearing fruits. It was also informed of the JRC's positive results in the Commission staff satisfaction survey.

The Board looks forward to a final agreement being reached on the Multiannual Financial Framework (MFF) 2021-2027, which should enable the EU to address upcoming challenges and deliver on the expectations of its citizens. Once the MFF has been agreed upon, the future Research and Innovation Framework Programme, Horizon Europe, should be adopted reflecting the highest possible level of ambition.

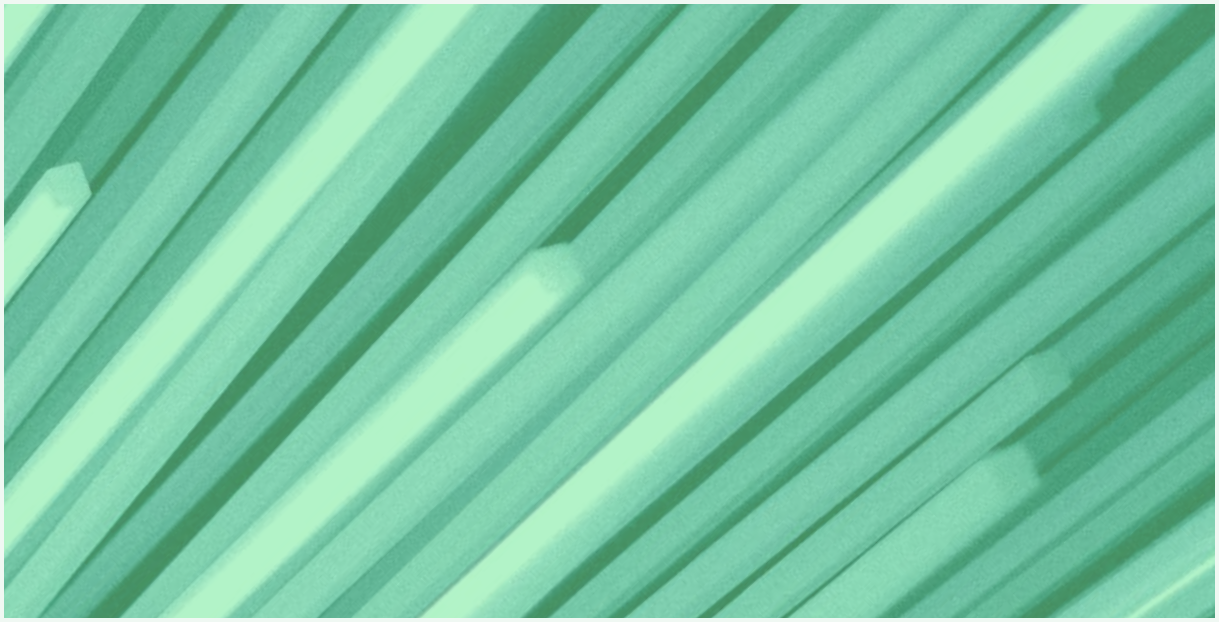
The Board has also been closely following negotiations on the Euratom Research and Training Programme 2021-2025 and nuclear decommissioning. It pledges to continue assisting and advising the Director-General and the Commission on the JRC's strategic role in implementation of the new instrument on nuclear decommissioning.

The Board endorses this Annual Report and reiterates its appreciation for the work of the JRC in 2019. It looks forward to providing continued guidance and support in 2020.

SCIENCE FOR POLICY IN TIMES OF TRANSITION

From the Sibiu Conference in May to the new Commission taking office in December, 2019 was a year of transition for the European Union: transition to new political priorities under the vision of President von der Leyen, defining the direction of the Commission over the next five years. The JRC, as the Commission's science and knowledge service, provided data, tools, knowledge and evidence to support this transition.

The Commission's political priorities, initiatives and proposals aim to tackle the challenges of our rapidly changing world. Technological, climate, societal, and geopolitical transformations are impacting jobs, industrial sectors, business models, the economy, the environment and society as a whole.



Many of the challenges we face are 'wicked' – they blend into each other, and their scale and scope is difficult to define. Practically any policy measure in one area has implications for others. This increases the stakes and complexity of policy issues enormously, which frequently gives rise to clashes in values. Scientific evidence can help to provide a more holistic view of today's wicked challenges from different perspectives, giving us a chance to understand and govern them in the right way. The JRC's work includes analytical, anticipatory, and complex system analysis approaches to these challenges.

We are undergoing a *digital transformation* characterised by the emergence of artificial intelligence (AI), the establishment of digital platforms as economic and social agents, and the use of data as the crucial element of the system. This transformation is big and complex and relies on other technological advances, for example in the fields of telecommunications, space technologies and computing power. Similarly, *biotechnology* is providing new tools for the sustainable development of agriculture, fisheries, forestry, and the food industry, while *'omics' technologies* – in particular genomics – impact individuals' lives and society in general.

The *climate transformation* brings about many challenges, from climate action and the reduction of greenhouse gas emissions under the framework of the Paris Agreement, to energy efficiency gains in a *transition towards decarbonisation* that preserves social fairness. The Coal Regions in Transition initiative is a good example in this respect. Environmental issues such as pollution, biodiversity loss and responsible use of land and resources revolve around *sustainability*. So does the circular economy, with important implications for technological innovation, and the creation of new markets and jobs.

The *evolving nature of work* and emergence of new work patterns impact labour markets, and their link with the educational systems endowing young people with an adequate set of skills to meet labour market needs. A number of *social issues* have come to the fore, starting with widespread inequalities, a growing perception of unfairness, increasing social discontent and fading trust, as well as well-being and health-related matters, including the worrying phenomenon of mental health issues among young people. Such challenges are further compounded by regional disparities, demographic developments characterised by the decline and ageing of Europe's populations, and the social aspects of migration. Finally, inclusive policymaking is challenging traditional practices, with concepts such as proximity to citizens, co-creation and stakeholder communities.

The scope of issues faced goes beyond Europe's borders and covers matters connected to *global diplomacy, governance,* and *security*. As the EU ambitions to lead on international issues, it faces the key challenge to be a frontrunner on climate change and sustainability, a partner in development and a powerful negotiator. Defining global rules and standards gives it a competitive edge, and international collaboration and diplomacy provide an opportunity to share and spread EU values. Security, on the other hand, has become a core concern for territories, businesses, organisations and citizens, with hybrid threats, cyberattacks, and the protection of critical infrastructure and public spaces becoming challenges of paramount importance.

These challenges require policies based on robust scientific data and evidence. The JRC has increasingly applied multidisciplinary approaches to address multifaceted problems. Throughout 2019, it continued to develop, collate and analyse knowledge, and to present it to policymakers in a coherent and digestible form – to help them deal with the deluge of data, information and knowledge that is now available and which, although incredibly rich, can be overwhelming. This Annual Report includes some of the highlights, from Facts4EU reports and supporting the implementation of policies to foresight activities, and actions bridging the gap between science, policymakers and society.

MANAGING KNOWLEDGE FOR EVIDENCE-INFORMED POLICY

With the 2016 Communication on Data, Information and Knowledge Management at the European Commission, the Juncker Commission set the direction for modernising the way the Commission operates. It indicated knowledge as the key to overcoming silo mentalities and to connecting synergies between portfolios, making our work leaner and more efficient.

Since then, that vision has borne visible fruits for the entire institution, such as a corporate data strategy, a generalised interest in information sharing and collaborative work practices, and a new awareness of instruments. These can help EU policymakers to factor in both evidence and values in designing more effective policies, as well as to communicate better with citizens, engaging them in the process.

Driven by its 'Strategy 2030', the JRC has been at the heart of this evolution, transforming itself from a traditional research-making organisation into a manager of knowledge for EU policies. In doing so, it gathered new experience and competences which are now ready to support the new vision set out in the 'political guidelines' of the then President-elect von der Leyen: a Union that strives for more, supported by a more agile and flexible Commission, more transparent in the way it works, in which European citizens have a greater say.

Implementing the JRC Strategy 2030 knowledge management objectives

While for the JRC, 2017-2018 were years of consolidation of its new organisational structure, 2019 proved to be about concrete application of its knowledge management capacity and expertise throughout the Commission and externally, sowing the seeds of a new approach to evidence-based policymaking. Best testified by the flourishing new series of #Facts4EUFuture reports, and by the success of its Knowledge and Competence Centres, this was also made clearly visible by the success of the second EC Knowledge Week (see below). The overwhelming attendance, as well as the fact that more than 100 local events were organised at four different locations involving 33 Commission services, confirmed that the knowledge-management culture has permeated the institution in a way that few would have considered possible just a few years ago. The event was also an opportunity to forge new links with other leading organisations in the international knowledge-management community, in view of future collaboration.

Within the Commission, the JRC continued to be one of the most active Directorates-General supporting the implementation of the Communication on Data, Information and Knowledge Management (DIKM). This was done through important initiatives, such as the continued management of the Connected Platform and support given to the European Semester process, and the consolidation, in collaboration with the Secretariat-General (SG) and other Directorates-General (DGs), of the One-Stop Shop for Collaboration and of a Corporate Data Strategy Action Plan. Some of these initiatives will be stepped up in the next Commission DIKM Work Programme (2020-2021).

JRC knowledge-management activities have also been intensifying, to better rise to the challenges of adequately informing policymaking despite not only the overwhelming amount of information available, but also the fact that much of it can be biased or even deliberately fake. After opening up the way with a dedicated #Facts4EUFuture Report, the JRC launched an ambitious programme to improve the understanding of the values held by European citizens and political parties. This should lead to the development of a practical analytical framework for policymakers, helping them to clarify the values behind each issue, informing the values trade-off process, and communicating with citizens.

Having established a dedicated Competence Centre on Foresight, the JRC has been consolidating and communicating its foresight tools and methods (the Megatrends Hub, sector-specific Scenario Exploration System for broader engagement, Horizon Scanning, etc.). It has also run foresight processes at the request of policy DGs. The studies undertaken by the Competence Centre on Foresight have engaged with different stakeholders and foresight communities in Europe and worldwide. The main objective is to embed foresight into the Commission's work to enable it to better develop future-proofed strategies and policies. In the next Commission, the JRC will support Vice-President Šefčovič in successfully implementing his foresight mandate.

As the Commission's science and knowledge service, the JRC is also particularly well positioned to deploy initiatives reinforcing the reciprocal links between science, policy and society. 2019 was the year for defining a comprehensive framework for communicating science to citizens through immersive, interactive and enjoyable experiences, empowering them in learning and behaviour. The key messages of that strategy are built on the premise 'our science behind policymaking for the benefit of all of us'. On one hand, this covers what the EU is doing in policymaking, with the emphasis on what it means for improving EU citizens' lives, thereby promoting engagement with the EU project. On the other hand, it focuses on how the science and knowledge within the JRC, and making sense of vast amounts of knowledge globally available, directly contribute to this goal. The ARTEFACTS project (see below) is a good example of this new approach.

Collaboration with science museums and virtual reality

In the framework of a collaboration with science museums, for 12 months up to October 2019, the JRC deployed the ARTEFACTS exhibition at the Berlin Museum für Naturkunde. The exhibition illustrated how science and politics work together to find solutions for urgent environmental issues of our time. It focused on the themes of food, energy, water, air and climate, thereby fitting perfectly with the Commission President's Green Deal priority.

The exhibition was a remarkable success. An estimated 600 000 people visited the museum, of whom 75 % saw ARTEFACTS, including 300 000 who dedicated 20 minutes or more to understanding and appreciating the leading role played by the EU institutions in ensuring an ecologically sustainable as well as economically prosperous future for Europe. The project also encompassed a digital version of the exhibition as well as a virtual reality experience, and provided a great opportunity to learn and progress on the use of social media and visual communication.

Building on this success, a new collaboration will start in 2020 with science museums in Milan and Paris, focusing on AI. It will pay greater attention to understanding public opinion about new technologies as well as explaining the EU's future role in ensuring balanced regulation to protect privacy while increasing economic productivity, most notably in security, transport and health. In line with these plans, JRC advances in virtual, augmented and digital exhibitions will be exploited further to develop new forms of science dissemination while grasping the momentum of the success and recognition of JRC excellence and its growing customer base and needs across the Commission.

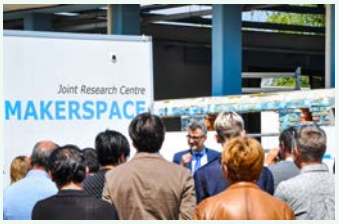
Important achievements in 2019

In the autumn, the JRC organised the second **European Commission Knowledge Week** together with the SG and DG Human Resources and Security (DG HR). It involved 33 DGs and Agencies, with more than 100 events in Brussels, Luxembourg, Ispra and Parma, a plenary conference and a workshop. Worldwide experts' speeches about knowledge management at the National Aeronautics and Space Administration (NASA), collaborative learning at the United Nations (UN) and collective intelligence development at the Massachusetts Institute of Technology (MIT) were given alongside Commission practitioners' presentations. An attendance of over 3 000 demonstrated the strong uptake within the institution.

The JRC's research on **Enlightenment 2.0** seeks to redesign knowledge for policymaking using behavioural and decision science. The recent report 'Understanding our political nature' (see page 15) shows how and why emotions, values, identity and reason all influence our decisions. This report will lead the way to further research, which will try to explain the influence of changing technological environments, identify areas of misperceptions in the EU about societal issues, and investigate how to turn these insights into practical tools and advice for policymakers.

Communities of Practice (CoPs) enable people with responsibilities and interests in the same or similar areas to learn from each other, collaborate on specific actions and ultimately build the Commission's knowledge capital in each area. Within these virtual environments, the institution's working culture can rapidly evolve towards better information sharing and collaboration. Based on its experience in this field, in 2019, the JRC developed a training course for the management of CoPs, which will be on offer for the whole Commission as from 2020.

As the flood of knowledge increases, there is a greater need for systematic reviews to guarantee better exploitation of scientific results and defining the way forward. The **Gaps Explorer** developed by the Disaster Risk Management Knowledge Centre (see page 10) gives an overview of the EU's research projects on selected topics, providing recommendations tailored to different stakeholder profiles – policymakers, practitioners and scientists – based on thematic reviews.



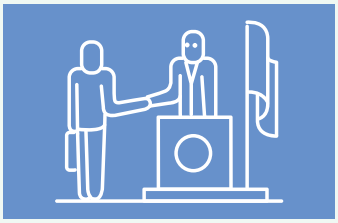
The JRC inaugurated an in-house **makerspace in Ispra** which can be used for multiple goals, ranging from internal collaboration (through lectures, co-creation sessions and prototyping workshops) to citizen engagement (by opening the space to the general public and wider scientific communities). Finally, for schools, the makerspace provides creative hands-on ways to encourage students to design, experiment, build and invent as they engage in-depth in the tinkering process.

The JRC is striving to bridge the gap between science and policy by training scientists and policymakers in how to use evidence. By December 2019, almost 400 JRC scientists had completed a course on the **'Practice of informing policy through evidence'**. In parallel, it has been developing, in collaboration with DG HR and SG, a skills map and training agenda for European Commission (EC) policymakers. It focuses on how to understand, obtain, interrogate and apply evidence in decision-making, including engaging with scientists and knowledge brokers and evaluating their input.

The **One-Stop-Shop for Collaboration (OSS)** provides a single source of advice for EC managers and staff on collaborative ways of working. Co-led by the JRC, SG, DG HR and DG DIGIT, under the auspices of the Information Management Steering Board (IMSB), to date the OSS has advised 12 DGs on 17 projects. This has helped to reduce inefficiencies and raise productivity for both high-value programmes, such as the Customs Union, and high-cost activities, such as conference management. In the next IMSB Work Programme (2020-2021), the OSS will scale up its activities.

The Knowledge4Policy web platform (K4P) provides a coherent view of JRC's results and activities in scientific knowledge for EU policy development. It is a virtual meeting place for scientific stakeholders and policymakers, designed to mobilise people and resources to create, curate, make sense of and use knowledge to inform policymaking. Fully operational since 2019, it hosts all the JRC Knowledge and Competence Centres and other knowledge services, such as the Artificial Intelligence Watch.

Digital tools extend our reach beyond physical constraints. The new **JRC Digital Media Hub** groups and makes available in one virtual place more than 200 pieces of content (videos, tutorials and 360° virtual lab tours) produced by the JRC, helping to communicate the knowledge we produce. It will soon provide space for new and more immersive formats, such as online storytelling tools, like the JRC Story Maps on Cultural Heritage and Artificial Intelligence, or the SELFIE tool supporting schools to go digital and promote digital teaching and learning.



Through its work on the **'Future of Migration in the EU'**, the JRC analysed trends and delineated migration scenarios towards 2030. These scenarios were applied to a set of interactive tools, creating a discussion toolkit which was then used by various stakeholders in their training sessions for migration officials and by Ghent University for its Public Administration Programme. A serious game about migration governance is being developed as an educational tool for secondary schools and will be finalised in the first half of 2020.

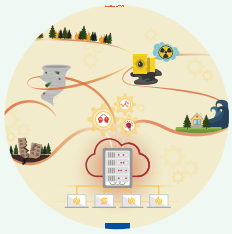
'Future of Government 2030+' analysed digital trends in our rapidly changing society to promote an EU-wide debate on future governance models, with a citizen-centric perspective. In March 2019, in Brussels, a related event was attended by 150 high-level EU, national and local policymakers and stakeholders. A 'FuturGov' exhibition presented foresight scenarios at various locations in Belgium and Luxembourg, and within this context, a 'FuturGov serious game' developed by the JRC was played in more than 20 sessions.

Knowledge and competence centres

Knowledge and competence centres are integral parts of knowledge-management activities. These virtual entities bring together experts, stakeholders and knowledge from inside and outside the European Commission. Knowledge centres are built around topics, while competence centres focus on analytical tools. Together, they inform policymakers, stakeholders and interested citizens about the latest scientific findings relevant to their respective remits. They provide contextualised evidence, reviews, data analysis and visualisation, communicating in a concise way through visual and digital channels. In 2019, a new competence centre – on behavioural insights – was launched, bringing the total operated by the JRC to 13. Emulating the JRC's initiative, the Knowledge Centre on Interpretation (KCI) launched by the Directorate-General for Interpretation in 2018, consolidated its position as the single go-to space on conference interpretation and more.

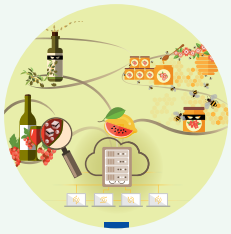
The **Knowledge Centre for Territorial Policies (KCTP)** gathers, manages and makes sense of the vast amount of knowledge available on European cities and regions to help boost their competitiveness, preserve their diversity, and improve their citizens' quality of life, while strengthening the EC's overall support for territorial development.

The **Knowledge Centre on Migration and Demography (KCMD)** provides evidence and knowledge for EU policies related to migration and demography. Supporting the European Agenda on Migration, the focus is on comprehensively and systematically analysing developments on a global scale and their societal impact on the EU in the medium to longer term.

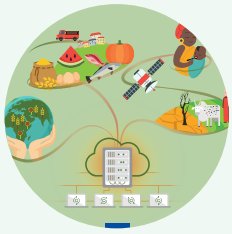


The **Knowledge Centre for Disaster Risk Management (DRMKC)** provides better knowledge, stronger evidence and a greater focus on transformative processes and innovation to improve our understanding of disaster risk, to build resilience and risk-informed approaches to policymaking, and to contribute to smart, sustainable and inclusive growth.

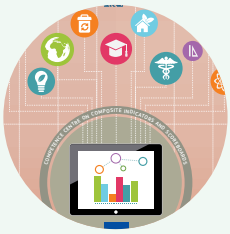
The **Knowledge Centre for Bioeconomy (KCB)** collects, structures and makes accessible data and information on the bioeconomy from different sources, pulling together the knowledge and expertise needed to assess the status, progress and impact of the bioeconomy.



The **Knowledge Centre for Food Fraud and Quality (KC-FFQ)** aims to create a formalised science/policy interface to support initiatives for safeguarding the quality and authenticity of agri-food products and to protect the integrity of the food chain. It complements the activities of the EU Food Fraud Network.

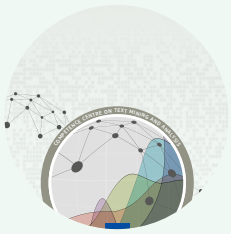


The **Knowledge Centre on Global Food and Nutrition Security (KC-FNS)** makes the existing information and tools available to EU policymakers and stakeholders, identifies priority topics to foster better knowledge and collaboration around these, and promotes the EC's role in generating new knowledge and supporting relevant international initiatives.

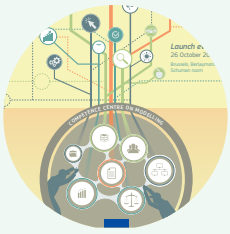


The **Competence Centre on Composite Indicators and Scoreboards (COIN)** develops methodologies to construct robust composite indicators that help policymakers shape policy and monitor progress. COIN is renowned worldwide for its expertise on statistical methodologies and technical guidelines.

The **Competence Centre on Microeconomic Evaluation (CC-ME)** helps to enhance the EU policy process through ex-post causal evaluation and impact assessment. It also provides advice on data collection and evaluation design, capacity-building on counterfactual methods, microeconometric analysis and counterfactual impact evaluation.

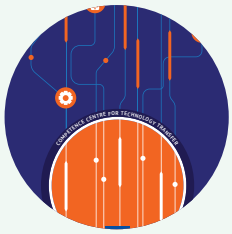


The **Competence Centre on Text Mining and Analysis (TMA)** addresses policymakers' needs for timely access to relevant information that is often buried in large amounts of textual data. TMA is relevant to virtually all policy areas and the centre provides the skills and expertise required: computational linguistic research, applied IT and support.

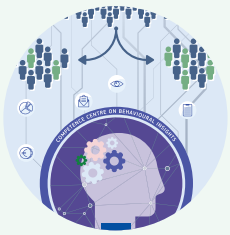


The **Competence Centre on Modelling (CC-MOD)** leverages modelling capacity and competences across the EC and beyond. Starting with a Commission-wide modelling inventory, it supports the proper documentation, use and reuse of models, further helps in identifying common approaches to quality and transparency of model use, and establishes a community of practice on modelling.

The **Competence Centre on Foresight (CC-Foresight)** provides direct strategic and future-oriented input into EU policymaking, boosts the uptake of foresight and forward-looking approaches, and continuously advances in-house foresight capacity, methods and tools to make it more practical for decision-making procedures. One of its most prominent outputs is the Megatrends Hub, a dynamic collective intelligence system assessing a set of 14 global megatrends relevant for the future of Europe.



The **Competence Centre on Technology Transfer (CC-TT)** complements other JRC activities in the broader domain of support for innovation policies and makes available operational experience and understanding of the technology transfer process – for example, for the practical implementation of smart specialisation strategies and a deeper understanding of the role of technology transfer in innovation ecosystems.



The **Competence Centre on Behavioural Insights (CC-BI)** provides the competences and tools for applying behavioural evidence in policymaking, liaising with international players such as the Organisation for Economic Co-operation and Development (OECD) through a Community of Practice. It identifies behaviours and specific groups to be analysed, collecting the relevant evidence, testing alternative policy interventions and eventually informing policy decisions.

#FACTS4EUFUTURE REPORTS

The new European Commission is under tremendous pressure to take a leading role in tackling the many challenges of change that the EU, like all global actors, is and will be facing for years to come.

The unprecedented speed of technological transformation requires action to maintain competitiveness, productivity and positioning in global value chains. It also pushes us to reflect on the societal model that we want to preserve – our visions on ethics, democracy and personal freedom.

Major societal transformations, such as changes to the nature of labour markets, demographic developments, the growing perception of inequalities, and the erosion of trust towards institutions, may put our very democratic model to the test.

The environmental transformation requires sustainability and resilience to be embedded at the core of any of the JRC's development strategies.

Furthermore, geopolitical balance will largely affect the outcomes of these strategies. For Europe, it will be essential to identify partnerships that can be mutually beneficial, while boosting industrial and trade policies to ensure a level playing field.

To address these challenges and ensure competitiveness and well-being for all EU citizens, the EC must rely on a solid analytical basis. This is why, in 2018, the JRC initiated the production of a series of future-oriented 'flagship' reports (#Facts4EUFuture) to provide a more solid understanding of some aspects of such challenges. The first published report focused on AI.

In 2019, the JRC published seven more reports in the #Facts4EUFutureseries, for example, on China; Demographic scenarios for the EU; Future of cities; Future of road transport; Understanding our political nature; the Changing nature of work; and Blockchain now and tomorrow. New reports expected to be published in 2020 will cover Fairness, Resilience and Cybersecurity.

These flagship reports highlight the anticipatory and analytical capacity of the JRC. They provide a state-of-the-art analysis of highly politically relevant and current research, integrating novel JRC data with broader overviews of the state of global knowledge in the field. They translate complex research into information that can be used for decision-making.

Thanks to the JRC's wide range of expertise, the reports look at multifaceted issues through an interdisciplinary analysis. The preparation of each report involved collaboration among JRC experts working in several different fields. This effort corresponds in full to the 'breaking silos" commitment in the JRC Strategy 2030.

Their preparation involved deep discussions and cooperation with policy DGs. The launch events of all the reports in Brussels saw the participation of policy DGs at senior management level. They were presented to policymakers on several occasions, in the Council, at the European Parliament and at events held by other EC services, as well as expert conferences and events.

A transversal reading of the reports may highlight some interrelated challenges the EU will have to face in the near future, such as the need for governance and the importance of rebuilding trust, ensuring sustainability, and investing in the EU's competitive advantage at global level.

Understanding global transformative trends

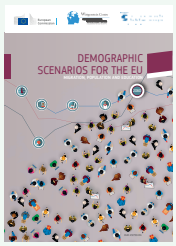
With its wide range of expertise, the JRC was able to look at multifaceted issues through an interdisciplinary analysis. The reports take stock of current knowledge and evidence, and translate complex research into useful information for decision-makers. They also look at future developments and, in some cases, develop future scenarios.

CHINA

(Published on 23 May 2019)

China is rapidly becoming a major industrial competitor in high-tech and growth sectors. Its economic success and related industrial policies have received a high deal of attention, especially in light of their capacity to challenge the leading position of advanced economies in several fields. China aims, through the 'Made in China 2025' strategy, to become a world leader in key industrial sectors. In these sectors, it strives to strengthen its domestic innovation capacity and to reduce its reliance on foreign technologies while moving up in global value chains.

This report analyses China's approach to attaining a dominant position in international markets through a combination of industrial, research and innovation (R&I), trade and foreign direct investment policies. It gives an assessment of China's current position compared to EU and US innovation systems across a range of dimensions. It concludes that China has become a major industrial competitor in several rapidly expanding high-tech sectors, which may well result in the country reaching its goal of becoming an innovation leader in specific areas. In response, the EU will need to boost its industrial and R&I performance and develop a trade policy that can ensure both a level playing field for EU companies in China and for Chinese companies in the EU.



DEMOGRAPHIC SCENARIOS

(Published on 4 June 2019)

With the EU's population ageing, the future EU labour force will be smaller. However, it will also be more highly educated and thus more likely to better adapt to changing employment conditions. The number of workers with a short post-secondary education (e.g. technical training), bachelor's and master's degrees or higher is projected to grow from 35 % to almost 60 % over the next 40 years.

Increasing labour-force participation, notably by women, is an effective strategy to address challenges from an ageing population. If all EU countries achieved the same labour-force participation rates as those in Sweden today (longer careers and high labour-force participation of both men and women), the labour force would stabilise at around 245 million workers in 2060.

Intra-EU mobility is leading to substantial population changes within the EU. In particular, some southern and eastern Member States face severely declining populations due to a combination of low fertility and sizeable emigration, especially of their young, working-age population.

FUTURE OF CITIES

(Published on 14 June 2019)

Notwithstanding the overall trend of growing urban populations, over half of European cities will see their population decline, while almost one in three will grow by more than 10 % in the next 30 years.

Cities are hubs of innovation and creativity, with high concentrations of educated people and financial means, and they can scale up solutions quickly and efficiently. New technologies will transform the way people interact, move, live and work. These technologies will need to be interoperable, integrated, and implemented in an inclusive way to benefit the overall functioning of cities and to ensure no one is left behind.

Housing in cities will have to be rethought to create efficient, affordable and inclusive neighbourhoods within the constraints of existing infrastructure. Key challenges include adapting infrastructure to achieve greater inclusiveness; housing affordability, especially for low- to moderate-income households; and building upgrades and conversion of abandoned spaces.

THE FUTURE OF ROAD TRANSPORT

(Published on 21 June 2019)

Road transport is directly linked to economic growth and employment and is an ever-growing contributor to carbon emissions, poor urban air quality and overall energy consumption.

A plethora of disruptive new technologies and social trends is entering the road transport sector, which has remained conceptually unchanged for several decades. Vehicle automation and connectivity, low-carbon technologies and sharing trends have the potential to make road transport more efficient, more accessible, more equitable and cleaner.

Nevertheless, initial evidence shows that without a proper policy framework, new technologies will maintain a vehicle-centric approach to mobility – with the risk of hampering potential sustainability gains. Ambitious and advanced road governance is needed to avoid this caveat and invert this ongoing trend. Although new technologies are great enablers, a strong political will is essential. The strong social and economic implications of any change to road transport calls for new governance models to be thoroughly tested with the direct involvement of citizens.

UNDERSTANDING OUR POLITICAL NATURE

(Published on 18 July 2019)

Behavioural sciences, social sciences and humanities can bring new insights on political behaviour – showing how and why emotions, values and identity affect how we take decisions on political issues. We need to learn to think about how we think.

We cannot separate emotions from reasoning. Emotions are just as essential to decision-making as logical reasoning, and are as likely to enhance rationality as to subvert it. Learning to integrate and use emotions could improve decision-making and collaboration in government.

The erosion of trust in experts and in government can only be addressed by greater honesty and deliberation about interests and values. Opening evidence to public scrutiny is crucial to maintaining scientific authority. Deliberative democracy and citizen engagement can be effective responses to the loss of trust in democratic institutions.

THE CHANGING NATURE OF WORK AND SKILLS IN THE DIGITAL AGE

(Published on 24 September 2019)

To date, new technologies do not seem to have had a significant impact on employment levels, although they will reshape millions of jobs in the EU. They are changing what people do on the job, and how they do it, by adding new tasks, modifying existing ones, and transforming work organisation. This is leading to the growth of employment and salaries in occupations requiring digital or non-cognitive skills, or a combination of both.

Digital technologies provide incentives for employers to contract out work, while enabling workers to work remotely and in novel structures. Thus, they are one of the main drivers of the rise of platform work, solo freelancers, and work contracts of short duration in the EU.

The employment landscape is evolving differently across the EU, with the divide both between and within EU Member States remaining large, and at times widening, especially between capital cities and other regions.

BLOCKCHAIN NOW AND TOMORROW

(Published on 8 October 2019)

Blockchain technology is still in the embryonic stage and faces many challenges, such as performance and scalability, energy consumption, data privacy, integration with legacy infrastructures, and interoperability. Still based on a limited set of proven use cases, blockchain often entails additional risks and barriers for businesses and organisations either piloting it or interested in its deployment.

Blockchain will complement or interact with other key digital technologies, such as AI, the Internet of Things, data analytics, cloud computing, robotics and additive manufacturing. To avoid overlaps while maximising impact, the development of blockchain should be connected to relevant initiatives and programmes.

Today, policy dilemmas involve balancing the adequate enforcement of existing regulations from day one, and flexibly accommodating an evolving technology with both foreseeable and unforeseeable benefits. Foresight and trend monitoring can help achieve this and enable preparedness and adaptation to an increasingly rapid pace of change.

ANTICIPATING FUTURE TRENDS AND SOCIETAL TRANSFORMATIONS

"Changes in climate, digital technologies and geopolitics are already having a profound effect on the lives of Europeans. We are witnessing major shifts all the way from global power structures to local politics. While these transformations may be different in nature, we must show the same ambition and determination in our response. What we do now will determine what kind of world our children live in and will define Europe's place in this new world", the President of the European Commission Ursula von der Leyen wrote in each of the Commissioners' mission letters, highlighting the need to anticipate changes and to derive well-balanced strategic policy options. "Our job as the European Commission will be to lead, to grasp the opportunities and to tackle the challenges that these changes present (...)"

The EC President is shaping the new Commission in an anticipatory way by using strategic foresight to help better design laws and initiatives and to develop future-oriented policies. Vice-President Maroš Šefčovič was given the mission to lead on this, drawing on the resources of the JRC as key enabler and multiplier.

Foresight

The JRC has a long experience in applying foresight methodologies to enable anticipatory long-term thinking in policymaking. The strength of this approach is in its ability to explore issues in a systemic manner, moving away from lock-ins and silo thinking. One of its successes is in overcoming the presentism bias and identifying alternative futures that can lead to policy recommendations serving the long-term but requiring actions in the present.

Foresight is a systematic participatory process, creating collective intelligence about the medium- to long-term future. It is aimed at informing present-day decisions and mobilising joint actions.

In 2019, the JRC published its first Future of Government 2030+ project with policy implications and recommendations, which highlights the shifting power relations in society with a specific focus on potential citizen-government relationships. The recommendations include a series of policy options and actions that could be implemented at different levels of governance systems.

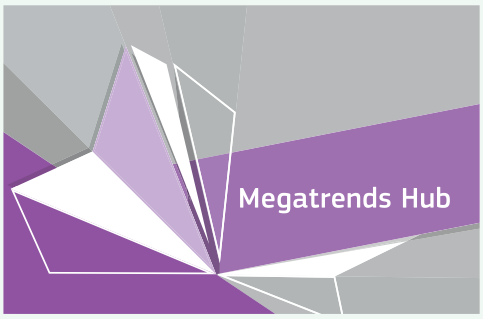
How could political decision-making from local to EU level as well as public service provision be improved? The project is based on a citizen-centric perspective with citizens' workshops in six Member States and a co-ideation process involving more than 100 design students at six leading European design schools. The project has developed four different scenarios that represent the world in which we might live in 2030 and beyond. Its aim was to launch an EU-wide debate on possible governance models. To continue this dialogue, an engagement tool using a serious game approach was developed and has already been taken up by NGOs.

The Competence Centre on Foresight is actively running foresight projects in various fields to support DGs in building anticipatory knowledge for policymaking and developing long-term strategies. In 2019, the issues covered were, for example, farmers, customs, blockchain for the social and public good, migration, and anticipatory innovation.

Another highlight in 2019 was the cross-JRC initiative to provide Facts4EUFuture, a series of reports on the future of Europe. The series covers global transformative trends that are characterised as rapid and complex changes:

- Technological development; with reports on the future of artificial intelligence, blockchain, and road transport
- New work and societal organisation; with reports on the future of work and skills, demography, cities, our political nature, fairness (forthcoming), resilience (forthcoming)
- Shifts in the geopolitical balance; with the report on China.

These reports bundle the knowledge available throughout the JRC and in the academic realm to provide an evidence base for EU policymaking and priority setting.



Horizon Scanning and Megatrends Hub

The Horizon Scanning and the Megatrends Hub are major pillars of the JRC's anticipatory work.

Horizon Scanning is a structured, systemic and systematic early-warning process. It helps to identify and monitor emerging issues that might have significant future implications for the EU but are not yet on the policy radar or being adequately addressed.

In 2019, the JRC internal process deepened through its experience- and expertise-sharing network; its utilisation has broadened through its application in various JRC projects beyond the overall policy-informing process. Besides the qualitative approach that covers all domains, in 2019, the JRC developed and published the first quantitative approach for emerging technologies, which is based on text-mining algorithms that analyse a corpus of scientific publications. The JRC is supporting DG Environment's EU Foresight System on Emerging Environmental Issues. The results of the first cycle was published in a report in 2019 and the support work for the second cycle has already started.

The Megatrends Hub is a dynamic collective intelligence system assessing a set of 14 global megatrends. A workshop approach was developed to understand the factors of change and their interplay and potential effect on society in a given policy field. This knowledge is helping policymakers to identify and assess possible actions and actors of change, understand priorities and design long-term strategies. Megatrends workshops on various issues were rolled out in 2019 in collaboration with other EC services, along with Member State and regional policymakers. The workshop approach is also being applied in EU agencies and other institutions.

COLLABORATING WITH INTERNATIONAL PARTNERS

Effective collaboration with the European and international research community is crucial for the JRC. By sharing knowledge, competences and facilities with over 1 000 partners worldwide, the JRC maintains a high level of expertise, informs policymaking with the best scientific evidence and tackles societal challenges.

JRC collaboration with Member States, partner countries and international partners takes many different shapes and forms. In 2019, highlights included supporting the EU's participation in major UN events; collaborating through smart specialisation with the Western Balkans, Ukraine, Moldova and Georgia; working with Japan on strategic areas such as AI; streamlining cooperation with South African partners; partnering with CERN on neutron data measurement and radioisotopes production; running a successful Refugee Scientists Programme; enhancing nuclear security preparedness; and continuing to foster European and global improvements in nuclear safeguards and non-proliferation, to name but a few.

United Nations (UN)

In 2019, the JRC's work underpinned EU participation at major UN events, including the UN General Assembly (September 2019) and the High-Level Political Forum (July 2019).

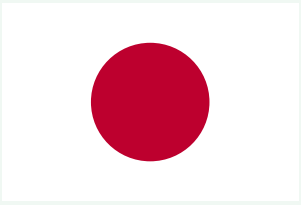
Throughout 2019, the JRC cooperated with the UN Department of Economic and Social Affairs on defining a methodology to underpin the development of science, technology and innovation (STI) roadmaps for the Sustainable Development Goals (SDGs) internationally. The methodology is partly based on the JRC's smart specialisation approach. It was notably included in a 'Guidebook for the Preparation of STI for SDGs Roadmaps', for which JRC colleagues provided significant input, not least through their participation in several high-level UN events. In April, JRC experts and their UN counterparts co-organised the Fourth Expert Group Meeting (EGM) on STI Roadmaps for the SDGs, in Nairobi, Kenya.

In May, the first-ever session of the UN-Habitat Assembly was the occasion for the JRC to organise the EC's official side event on 'Open Data and Tools for the New Urban Agenda'. Urban forecasting systems, territorial modelling tools and indicators were among the themes to which the JRC contributed its expertise. The event paved the way for a strategic collaboration perspective in the scientific domain with the UN-Habitat and clearly acknowledged the JRC's role and activities on cities. In 2019, the JRC also furthered its work with the UN-Habitat for the development of a Global Definition of Cities and Settlements.

The JRC also continued active collaboration with the Food and Agriculture Organization (FAO), in particular in relation to the use of Earth observation data, and by cooperating on the State of the World's Land and Water Resources for Food and Agriculture (SOLAW) report, as well as work on food crises and the successful ongoing cooperation with the Global Soil Partnership.

The JRC and the UN Environment Programme have been exploring cooperation on water quality and its central role in sustainable development, including the nexus with food, energy, biodiversity, ecosystems, health and emerging issues. In this context, in September, the JRC hosted the second meeting of the UN World Water Quality Alliance and will be working towards a fully-fledged World Water Quality Assessment.

The JRC also took an active part in the UNFCCC 25th Conference of the Parties (CoP25), and organised three side events on modelling in long-term strategies, indexes for sustainable development and climate action, and greenhouse gas (GHG) fluxes.



Japan

In the framework of the Research Framework Arrangement concluded in 2017 between the JRC and Japan's National Institute of Advanced Industrial Science and Technology (AIST), the collaboration in the sectors of energy and transport, nanotechnology, disaster risk reduction and management, space observation, AI, critical raw materials has progressed very successfully.

In particular, AI emerged as an area of mutual interest that is being greatly valued as regards the strategic relevance that both the EU and Japan attach to the development of human-centred, ethical, secure AI capacities. In this context, researchers from AIST/AIRC (AI Research Centre) have worked with JRC researchers at the JRC Disaster Risk Management Unit on the production of a land-cover map using full-polarimetric data.

The JRC's collaboration with AIST underpinned the initiative launched by Japan in October in the context of its G20 Presidency – the conference for R&D institutes of G20 members in the field of clean energy technologies. The JRC made a prominent contribution to the discussions on the specific and collaborative initiatives needed to achieve the concept of 'a harmonised virtuous cycle of environment and growth'. Moreover, the JRC was actively involved in the Moonshot International Symposium – in the session on Sustainable Resources Circulation for Global Environment – which the Japanese Council for Science, Technology and Innovation (CSTI) organised in Tokyo as the kick-off event of the Japanese Moonshot Research and Development Program.

In the course of 2019, the JRC hosted several delegations from Japanese institutions interested in exchanging knowledge and experience on topics such as evidence-informed policymaking, policy-impact evaluation methodology, citizens' engagement, and the communication of science and technology transfer.

* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence. This note applies to the whole document and each time Kosovo is mentioned.

Western Balkans

The JRC has been pursuing its collaboration with the Western Balkan economies in the context of the Smart Specialisation Framework, which was used as a basis for guidance, supported by capacity-building activities. There is a growing institutional awareness that smart specialisation strategies contribute to boosting growth and innovation in the region.

Another important collaboration framework is the Covenant of Mayors initiative, co-chaired by Vice-President Frans Timmermans, where the JRC advises cities in the region on developing their Sustainable Energy and Climate Action Plans, which includes the strategies and key actions local authorities intend to undertake. The initiative tackles three pillars which are regionally tailored: climate change mitigation, adaptation to the adverse effects of climate change, and universal access to secure, clean and affordable energy. The JRC set the initiative's methodological basis in this region, including guidebooks for local authorities, training on capacity building, and developing the new 'standard' for city emission reporting, targets and action plans.

Throughout 2019, important steps were accomplished with JRC support, in particular in Montenegro and Serbia. Montenegro's smart specialisation strategy, adopted in June 2019, is being assessed by the EC services, while Serbia is finalising the draft of its smart specialisation strategy document and plans to initiate the adoption phase in early 2020.

Other Western Balkan economies are in the process of launching the initial steps of the smart specialisation process. North Macedonia is currently mapping the country's economic, innovative and scientific potential, while Albania has completed all the preparatory tasks for entering the mapping phase. Bosnia and Herzegovina and Kosovo* are just starting the smart specialisation process. Specifically, Kosovo has already established a smart specialisation working group.

The JRC is also implementing the EU4TECH project Capacity building in technology transfer for the Western Balkans. Within this framework, 15 universities with sufficient research capacity have been identified to set up and reinforce their technology transfer offices and promote the development and exploitation of promising research projects.

EU4TECH supports the acceleration of technology transfer and the commercialisation of research results in the Western Balkans by delivering training and capacity building to technology transfer professionals, universities, research centres, early-stage investors and start-up companies. It also intends to explore policy options in a number of related domains.

The project's ultimate impact is to unlock the economic benefits of research generated in universities and research centres by transforming it into services and products, leading to the creation of new companies and employment opportunities, to increase economic growth in the regions and produce a strong social impact on local societies.

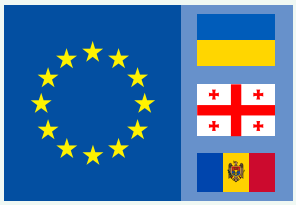
To support and promote the smart specialisation approach and transnational cooperation in the region and across the broader South-East Europe area, the JRC launched a series of events under the overarching process known as the 'Sofia initiative'.

The 2019 Sofia high-level conference 'Supporting Smart Specialisation and Technology Transfer in South-East Europe' took place in Bucharest in June 2020. It enabled smart specialisation in the Western Balkans to be adopted as an important tool to promote transnational cooperation in the region and to provide a dialogue forum for discussing strategic innovation policies and identifying priorities of common interest.

The progress of the Western Balkan economies in smart specialisation was also on the agenda at two important events in 2019: the 5th Joint Science Conference of the Berlin Process/Western Balkans Process, held in London at the end of May, and the Forum of Cities and Regions - Investing in Western Balkans, Investing in Europe, held in Rzeszow in Poland at the beginning of June.

Finally, the JRC's work has been supporting cross-sectoral and cross-policy approaches at the regional level through tailor-made activities promoting evidence-informed policymaking. The first Science meets Parliament pilot event in the Western Balkans region, which took place in Belgrade on 10 July 2019, focused on climate change.

Further activities in the area included assessing the status of atmospheric pollutants and GHG with a view to providing scientific evidence and building local capacities; developing transport sector indicators (accessibility, air connectivity, etc.) based on big-data analyses; assessing competitiveness and R&I capacities in low-carbon energy technologies and associated value chains in the region; and exploring options for tackling energy poverty in the Western Balkans.



Eastern Partnership

The JRC has been collaborating with Ukrainian organisations in the context of deployment of the smart specialisation methodology. Specifically, in 2019, support for Ukraine included:

- Risk Assessment for 2019-2020 accompanied by recommendations to the Ukrainian Competent Authority (Ministry of Energy and the Coal Industry). The support included the creation of a disconnection order list which would allow, in case of very severe gas crises, the application of a systematic, fair plan for the disconnection of customers, following the key indications of the Ukrainian legislation (fully in line with EU legislation). JRC support ensured that Ukraine's operation of the natural gas infrastructure, its risk management and market operation are aligned with EU provisions.
- Supporting the development of a Winter Action Plan for natural gas supply in Ukraine (winter 2019-2020), following a request from the National Security and Defence Council of Ukraine to improve their understanding of possible threats and vulnerabilities, originaing mainly from Russia, and the potential for different counteractions and remedies. The plan featured a number of scenarios that could occur in Ukraine in the winter of 2019-2020 based on the Risk Assessment. In addition, JRC and Ukrainian experts advised on mitigation measures which enabled Ukrainian authorities to develop strategies to cope with the scenarios considered, paving the way for the signature of a gas transit contract between Russia and Ukraine in 2019.
- Institutional capacity building: a double workshop (two parallel events) was organised in Kiev in March. It was a training session for all the Ukrainian regional smart specialisation teams and the national expert team for analytics. The training attracted around 120 participants, with representatives from all the regions and the key ministries (economic development, regional development, education and science).
- Development of guidelines and readily available databases for Ukrainian experts on how to run the mapping exercise in the Ukrainian context, followed by mentoring by the JRC's international expert for mapping who delivered training and consultations for over 50 Ukrainian experts in July.
- Launch of an expert pool to support the most-advanced regions in further stages of the smart specialisation process: preparation of the entrepreneurial discovery process (EDP), policy mix, monitoring system and financial and policy mix for smart specialisation.

The Republic of Moldova is developing a smart specialisation strategy at the national level. The process is being led in a decentralised way, including the mapping exercise and entrepreneurial discovery process which is focusing on regions. Four workshops took place in June, with a total of 190 participants. These events helped to attract participants from business, universities and the public sector for the inclusive discussion, which provided a significant impetus towards the development of a smart specialisation strategy.

Georgia is starting work on smart specialisation. The JRC has trained representatives of the future National Smart Specialisation Team. Smart specialisation was also included as a recommendation presented to the Georgian Parliament in October 2019. The same month, the JRC co-organised an awareness event on smart specialisation for the key ministries and agencies (for around 30 participants). In August, the JRC received confirmation of the appointment of the Georgian National Smart Specialisation Team which includes 25 representatives of the key ministries, the National Innovation Agency and the Statistical and Patent Office. On 25 and 26 September, in Ispra, the JRC organised the first study visit for a high-level Georgian delegation, which was one of the deliverables foreseen by the high-level meeting held in Brussels on 21 November 2018 between the European Commission and the Government of Georgia.

South Africa

In December 2018, signature of the Collaboration Arrangement with South Africa's Department of Science and Technology (DST) provided an institutional framework to streamline the very fruitful cooperation with the different South African partners placed under the South African DST's leadership. The final adoption of the White Paper on Science Technology and, in March, the SA government's pledge to increase the national budget share for R&I from 0.8 % to 1.5 %, signalled the country's growing commitment to research and innovation.

In 2019, the themes of smart specialisation, critical raw materials and the circular economy, evidence-informed policymaking (EIPM) and technology transfer emerged as specific fields in which there is great potential for developing scientific collaboration between the JRC and SA. These topics were at the centre of both bilateral discussions with SA delegations who visited the JRC in Brussels and Seville in spring 2019, and the JRC's participation in the 16th meeting of the EU-South Africa Joint Science and Technology Cooperation Committee, in April 2019.

Exchanges on the circular economy intensified further during 2019. The JRC was actively involved in the 'Circular Economy Dialogue' organised by the South African Department of Science and Innovation (formerly the Department of Science and Technology) with the support of the EU-SA Dialogue Facility, to inform the Department's Decadal Plan. In November, the JRC also participated in the SA-EU Symposium on Circular Economy, organised in Pretoria by the SA Department of Science and Innovation. As a result, a South African study visit to JRC Ispra will be organised in 2020 to establish a regular exchange between the JRC and SA institutions around effective models for the transition to a circular economy. Besides enhancing reciprocal knowledge and scientific solutions in support of the circular economy, this exchange will potentially contribute to upcoming European Green Deal efforts.

Contribution to the Integrated Carbon Observation System (ICOS) – a pan-European Strategic Research Infrastructure

The Integrated Carbon Observation System (ICOS) is a pan-European strategic research infrastructure which plays an essential role in quantifying GHG sources and sinks. It will help to support and improve GHG reporting in both the EU and its Member States, as required under the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement.

The JRC contributes to both the ICOS operational atmospheric network with the EC Atmospheric Observatory at the JRC site Ispra and, as of November 2019, to the operational network of terrestrial ecosystem stations with the micrometeorological station at San Rossore, close to Pisa in Italy.

The EC Atmospheric Observatory at Ispra was certified as an official ICOS class-2 atmospheric station in November 2018. The station provides high-accuracy continuous measurements of carbon dioxide (CO2), methane (CH4) and carbon monoxide (CO), measured from the air at the Observatory's 100-metre tower. Currently, there are only 23 atmospheric stations in Europe that have been certified by ICOS, and the JRC station at Ispra is the only surface station bordering the Po Valley region which is one of Europe's GHG emission hotspots. The atmospheric ICOS measurements are used by inverse atmospheric models to provide regional and European estimates of GHG emissions.

The micrometeorological observatory at San Rossore studies the exchanges of GHGs and H2O, and energy, between the terrestrial ecosystem and the atmosphere. It is one of the oldest stations and time series of this type in Europe and the only one above an evergreen needleleaf forest (pines) in the Euro-Mediterranean basin. The San Rossore Observatory obtained the official ICOS labelling as a class-2 ecosystem station in November 2019. To date, 22 ecosystem stations in the network have been awarded such a label, only 13 of which as class-2 or class-1 status, i.e. stations fully compliant with ICOS requirements in terms of measurement standards and data quality.

JRC Refugee Scientists Programme

Following a successful pilot initiative in 2017, the JRC developed a programme in 2019 to host and mentor scientists and researchers who are refugees based in Europe. The aim is to support the particpants' career development prospects by providing training on the JRC and its activities, European science, research and funding programmes, and developing practical job-market relevant skills. The JRC collaborated with the World Academy of Sciences (TWAS) and the Global Young Academy (GYA) which provided advice and support, including in finding suitable applicants.

In 2019, the programme hosted 10 selected participants. They came from various countries (Afghanistan, Venezuela, Syria and Yemen) while currently living in the Netherlands, Spain, the UK, Belgium, Germany, France, Italy and Norway. They had diverse scientific backgrounds (e.g. labour market, energy/computer engineering and storage, disaster risk management/climate change, biochemistry and public health); 40 % of them were women.

A workshop at the JRC in Ispra was co-organised in April 2019 with the GYA's Europe-based at-risk scholars mentoring programme. It provided career-relevant information, networking opportunities and practical skills training for the candidates in the JRC scientists programme. The workshop also introduced participants to the JRC's activities and labs. More specifically, the workshop involved a skills day (CV and application writing, interview practice, evidence for policymaking, and opportunities for networking) and a day to explore funding opportunities, including the Erasmus and Marie Curie funding schemes for individuals.

The programme also offers individual coaching sessions for career counselling to each participant by an executive coach and human resources consultant. The participants and the coach reviewed and rewrote their CVs and their motivation letters, which was followed by sessions to discuss their individual needs and objectives.

In May and June 2019, on the basis of their scientific backgrounds, the participants also visited (e.g. for three to five days) relevant JRC units. These visits offered an introduction to the JRC's work and to the European research landscape, participation in lab-based/research work and opportunities for awardees to share their research experiences with JRC staff. The feedback from the participants was very positive in terms of career development (e.g. learning new scientific knowledge, setting up a network with the JRC) as well as with regard to gaining self-confidence for working as scientists in Europe.

Moreover, participants were offered long-term mentoring opportunities from members of the JRC Alumni Network with the aim of jointly defining the skills and knowledge to be developed to support their careers. The mentoring partnership takes place via email and Skype (frequency depending on needs) typically for a period of 6 to 12 months. Mentors are researchers/scientists and professors from Portugal, Spain, France and Greece.

The European Organization for Nuclear Research (CERN)

The positive and long-lasting cooperation between the JRC and CERN was reinforced through the Memorandum of Understanding between the European Commission and CERN signed in 2009.

They cooperate in scientific domains such as neutron data measurements in the framework of the n-TOF (neutron time-of-flight) experiment, using CERN and JRC GELINA facilities, and medical radioisotope production. In 2019, the JRC officially became a participant, along with other European and international partners, in the CERN-MEDICIS project, the aim of which is to produce radioisotopes for medical applications.

Moreover, CERN and JRC are further strengthening their collaboration through the exchange of information and best practices, notably in the field of big data (where the main activities relate to storage, data access and analysis), knowledge transfer (via the European Technology Transfer Offices Circle coordinated by the JRC), and arts and science programmes.

EUSECTRA – A unique platform for enhancing nuclear security preparedness

The JRC-operated European Nuclear Security Training Centre (EUSECTRA) continued to serve as a platform for professional development and for highly specialised training, complementing national-level trainings. EUSECTRA's main stakeholders include EC services, international organisations (International Atomic Energy Agency, Europol) and global initiatives, Member States' authorities and the US Department of Energy (US-DOE).

In 2019, 14 one-week trainings covered areas such as nuclear detection, mobile detection and train-the-trainers. Another two workshops on securing major public events and on competency analysis of front-line officers also took place. In support of the Global Initiative to Combat Nuclear Terrorism, a workshop on reach-back capabilities was held at the JRC Karlsruhe site.

The EUSECTRA external training area at the Karlsruhe site was enhanced to enable more realistic, scenario-based training for surveying cargo containers and for greater capabilities to use mobile detection systems.

The scope of EUSECTRA activities continue to broaden: a new curriculum for radiological crime-scene management was developed in cooperation with national experts and Europol; e-learning modules on nuclear detection were developed for customs officers, for the Directorate-General for Taxation and Customs; and training videos on detection, mobile detection, radiological crime-scene management and nuclear forensics were produced in English, French and German.

Based on feedback from the training sessions and upon specific requests, the syllabi are continuously reviewed and optimised. This includes detection training of front-line officers, which was reviewed in cooperation with the US-DOE's Office of Nuclear Smuggling Detection and Deterrence. A new syllabus is being developed on processing a multiple hazard situation (such as disarming an explosive device in a radiological environment). Future developments will include robotised detection and drone-based detection (in cooperation with the German armed forces).

EUSECTRA also serves as a pilot project for the EU Academy concept, where online teaching material for nuclear detection and response will be available in the future.

50 years of fostering European and global improvements in nuclear safeguards and non-proliferation

The European Safeguards Research and Development Association (ESARDA) was established to facilitate collaboration in research and development and its application to the safeguarding of source and special fissile materials, coordinating and harmonising partners' R&D work. The association provides a unique opportunity for research organisations, safeguards authorities and nuclear plant operators to exchange information on new aspects, recent developments and research activities in international safeguards and non-proliferation. The JRC plays a particularly important role in ESARDA: holding the secretariat, being an observer at the executive board, participating in the working groups, and hosting the Association's web page.

The 2019 ESARDA Symposium marked its 50th anniversary. Over 50 years, ESARDA has evolved from implementation of the first integrated approaches to experiments and safeguards for European nuclear fuel-cycle facilities to the latest international non-proliferation challenges. ESARDA was involved in the creation of support programmes for the International Atomic Energy Agency (IAEA) safeguards, the launch of many projects on safeguards and nuclear material accounting and control in the Commonwealth of Independent States, the introduction of the Additional Protocol (to IAEA safeguards agreements), and contributing to the IAEA's implementation experiences on the State Level Approach.

Recently, points of interest at ESARDA included issues linked to digital transformation that offer both new opportunities and challenges in the testing, validation and performance evaluation of technological innovations. Other important topics covered strategic trade control, safeguards by design, and education and training.

Climate change diplomacy, modelling streamlining and outreach

The drivers of climate change and biodiversity loss know no national borders. This is why it is important that the EU continues to lead international efforts and builds alliances with like-minded parties around the world. The JRC contributes to these efforts by supporting DG CLIMA in the context of the UNFCCC. The JRC performed quantitative analysis of ambition levels and economic impacts by region. These results are being presented at the relevant fora, including during COP25, and are an important part of international negotiations.

In 2019, the JRC reinforced its activities related to modelling and database exchanges, capacity building and shared analyses with crucial global partners in the climate change arena. Some of these interactions have been framed within the EC's Strategic Partnerships for the Implementation of the Paris Agreement (SPIPA). Through these initiatives, the EC is reaching out to G20 countries in order to continue and strengthen engagement with the Paris Agreement. Modelling is one such activity. Others have been developed based on bilateral collaborative research agreements, like that signed between the JRC and the Chinese National Center for Climate Change Strategy and International Cooperation (NCSC) in 2018.

The JRC is authoring the Global Energy and Climate Outlook (GECO) reports which are made publicly available annually in advance of the COP and serve as a basis for discussion with international partners. The 2019 edition of the GECO analysed the role of electrification in global transition pathways to a low GHG emissions economy. Electricity is already considered to be an increasingly important energy carrier in final energy consumption in the absence of climate policies stronger than those currently in place (reference scenario), while enhanced electrification of final energy demand is a crucial element of the 2 °C temperature change scenario, paving the way to climate neutrality. For the 2019 edition, the JRC counted on the contribution from NCSC staff kindly detached to the JRC by the Chinese Administration. Similar collaborations and staff exchanges are foreseen with other SPIPA partners.

The JRC also presented its results and contributions at specialised workshops, as well as in the framework of the international Energy Modelling Forum and in country-specific workshops (e.g. India, Russia), in the search for deeper collaboration formats.

SCIENCE MEETS PARLIAMENTS, SCIENCE MEETS REGIONS

In 2015, the JRC and the European Parliament Panel for the Future of Science and Technology (STOA) launched 'Science meets Parliaments', which has since become an annual event organised at the European Parliament (EP). The objective of this initiative was to build closer links between scientists and EU policymakers in order to promote a culture of evidence-informed policymaking.

However, policymaking also takes place outside the Brussels bubble, and the regional and local dimension is vital. This was ultimately the rationale to launch the pilot project 'Science meets Parliaments, Science meets Regions'. This project extended the initiative across Europe, with 26 events in 22 Member States, and even one in an Associated Country.

The project went into full swing in the course of 2019, with many inspiring and engaging events, showing a clear need for this type of instrument for promoting evidence-informed policymaking at all levels of governance.

An instrument of collaboration with stakeholders in Member States

In 2016-2017, a number of pilot events had already taken place across Europe (Karlsruhe, Hessen, Trieste, Bratislava, Sofia and Espoo). A final high-level event concluded this initial phase.

The initiative was so successful that the EP decided to finance a pilot project Science meets Parliaments, Science meets Regions, which put in place a systematic framework to promote evidence-informed policy at the (sub)national level. It comprises three main lines of action:

1. Events and innovation camps, under the full ownership of the authorities concerned, and focusing on a topic relevant at the regional/national level
2. Scientific studies to support these events and their follow-up,
3. Educating policymakers via a pilot course on basic skills and attitudes to integrate science into policy.

The project took on board all actors of the 'quadruple helix': national, regional and local authorities were the driving force behind the events, but academia, businesses and civil society organisations were significantly involved, too.

The initiative, which also enabled policymakers to learn how to deal with evidence (complementary to JRC's tried-and-tested approach to teach scientists how to speak to policymakers), will come to fruition in the first half of 2020.

The evaluation of this pilot phase got under way at the end of 2019, with a view to reflecting on how a future 'Science meets...' instrument might look.

Indeed, initiatives are popping up in various Member States at (sub)national level, and instruments in line with this pilot project might help support and streamline these grass-roots procedures.

Science Meets Parliaments

European Parliament (Brussels)

Science meets the European Parliament

The annual Science meets Parliaments event was held in Brussels on 6-7 February. The focus was on JRC's flagship reports, with several panel discussions and breakout sessions dedicated to them. For example, there was a high-level panel discussion on AI and a breakout session on the future of road transport.

The event was very well attended and brought together numerous policymakers and scientists, discussing a wide range of policy topics. It also marked the formal launch of a series of regional events.

Representatives from each of the organising cities, regions and countries were invited to attend and were given the opportunity to exchange best practices during a workshop. They could also learn about the JRC's work through various sessions in the programme and via the new JRC exhibition inaugurated at this occasion by Commissioner Navracsics.

Science meets the Region of Satakunta

How to develop tourism in a coastal area with a lot of potential, while paying attention to environmental protection and the interests of local inhabitants? This question was at the heart of the event in Pori, in Western Finland. Policymakers from the regional council, local and international academics, as well as citizen organisations were present in large numbers and were also able to see the new JRC exhibition which was shipped to Pori for the occasion.

The event had been well prepared via a scientific survey among local stakeholders to gauge the impact of tourism development in the region and to identify the hot topics.

Science meets the National Parliament of Greece

As one of the national authorities involved in the pilot project, the national Parliament of Greece chose the hotly debated topic of migration for its event. The focus was less on issues of reception and admission but more on the problem of integrating migrants into Greek society (the same topic was tackled, although from a different perspective, in the innovation camp in Barcelona – see the list of events).

The JRC was represented by the Knowledge Centre on Migration and Demography (KCMD), while DG HOME's Deputy Director-General explained EU migration policies to the audience comprising policymakers, scientists, and civil society organisations. Greece also made use of the possibility to finance a follow-up study on the topic of the event, carried out by the national centre for social research.

Science meets the City of Sofia

It might be assumed that the big policy decisions in the EU are taken at national and supranational level. However, when it comes to implementation and impact on the ground, municipalities play a crucial role which is why the JRC was keen to also involve some cities in the pilot project.

Sofia was a case in point. The organisers chose the *innovation camp* format (a participatory methodology co-developed by the JRC in the framework of the Entrepreneurial Discovery Process for Smart Specialisation). The topics addressed can broadly be summarised under the heading of sustainable development: how to organise our mobility in the future, how to make our air cleaner, and how to innovate without leaving anyone behind? Once again, local research capacity was put to good use to deliver a feasibility study on using distributed sensors to measure air pollution (thereby linking to the topic of citizen science).

REACHING OUT TO STAKEHOLDERS AND CITIZENS

The JRC strives for scientific excellence, an important element of which relies on our ability to share knowledge and information with our partners and the broader outside world. As a multidisciplinary organisation, the JRC works with a large variety of stakeholders: policymakers at all levels of government, from international to local, as well as scientists and academics from private and public organisations alike. It also engages in outreach activities towards the public, which go well beyond the legitimate need of any organisation to raise its profile vis-à-vis its stakeholders. One of the JRC's key roles is to engage and share knowledge and expertise with the widest possible audience.

In 2019, activities that contributed to these core aspects of the JRC's mission included targeted initiatives, such as open access to JRC research infrastructures, engaging with the European Council and European Parliament, the JRC schools programme and citizen engagement programme, as well as the JRC Alumni Network.

As in previous years, events, media outreach, social media interaction and publications also played their role.

Engaging with the Council and European Parliament

In an effort to put science and evidence at the heart of EU policymaking, the JRC has further strengthened its cooperation with the European Parliament and the Council of the European Union.

In cooperation with the Romanian Presidency of the Council, it organised a one-day conference on Supporting Smart Specialisation Strategies and Technology Transfer in South East Europe, welcoming more than 200 participants in Bucharest in June. The JRC also organised informal working breakfast meetings with the Council's research working party on opportunities and challenges of future technologies, under the Romanian Presidency, and on analysing the challenges for the future of Europe, under the Finnish Presidency.

Important JRC input was also provided at several working group meetings under the Romanian and Finnish Presidencies, addressing a wide range of research topics including the future of space research, hybrid threats and EU crisis-management architecture, to name but a few. A group of young Romanian scientists visiting JRC's Ispra site as part of the cooperation activities with current Presidencies had interesting and fruitful exchanges with JRC scientists and visited JRC flagship laboratories. Finnish young scientists also visited the Ispra site and were given the opportunity to exchange views with members of the JRC Board of Governors.

In Bucharest in June, during the Romanian Presidency, at the informal meeting of ministers responsible for urban matters, the JRC presented its report on the Future of Cities. It produced a series of reports to support strategic reflection in the new Commission, by mobilising its multidisciplinary expertise. Other JRC reports have also been presented to respective Council preparatory bodies, such as the report on the Future of land transport and the Changing nature of work and skills in the digital age, under the Finnish Presidency of the Council.

Throughout 2019, the JRC also organised workshops and presentations as well as many informal meetings with MEPs and EP bodies. There is a growing interest in committees in presentations as well as in informal exchanges. Everyone who participated realised the vast wealth of the JRC's expertise and is interested to both have and use it.

The JRC established and deepened contacts with the EP's Research Service, the Committee on Industry, Energy and Research, as well as other committees dealing with transport, environment, health and the internal market.

Working ever more closely with Member States and the EP plays an important part in shaping Horizon Europe, the next EU Framework Programme for Research and Innovation.

Open access to JRC research infrastructures

The open access to JRC physical research infrastructures initiative was launched in 2017 to allow, under certain conditions, the research community, public authorities and industry in EU Member States and countries associated to Horizon 2020 to make use of its unique facilities.

The initiative is part of the JRC's strategy to enhance scientific knowledge dissemination, boost competiveness, bridge the research-industry gap, and provide training and capacity building. Access is provided in two modes: relevance-driven and market-driven.

Relevance-driven access is mainly granted in areas relevant to the JRC's strategic priorities and is of importance for European standardisation, integration and cohesion, sustainable growth and competitiveness. It is based on a peer-review selection process following calls for proposals.

Market-driven access is granted upon payment of a fee covering the JRC's full access costs, and is mainly targeted at industry. Projects are selected on the basis of their strategic importance for the EU.

In 2019, the JRC offered access to 16 research infrastructures: the nanobiotechnology laboratory, the reaction wall and the Hopkinson bar facility at the European Laboratory for Structural Assessment (ELSA) in Ispra; three energy-storage laboratories and four environmental and mechanical materials assessment facilities for nuclear reactor safety and emergency preparedness in Petten; four nuclear reaction and decay data measurements facilities in Geel; and two actinides for safe and secure operation of nuclear applications facilities in Karlsruhe. Furthermore, in 2019, the Nanobiotechnology laboratory piloted a new one-week JRC initiative on Training and Capacity Building for Enlargement and Integration Countries hosting and training on different topics 19 young scientists from Armenia, Bosnia and Herzegovina, Serbia, Switzerland and Turkey.

Since its launch, the initiative has provided access to 117 institutions and 278 users from 20 countries. The programme will gradually be extended to include another 23 facilities.

The JRC school programme: ignite passion for EU science in youth

Dissemination specifically targeting school-age citizens is extremely important as they are the future of the EU and emerging creators of new and powerful citizen youth movements . To seize the opportunity, the JRC has created a new school programme which targets local schools around each of the JRC sites but it also welcomes schools from different Member States. The JRC has also signed a Memorandum of Understanding (MoU) for collaboration with the European schools.

The school programme features a number of site-specific initiatives. Examples include individual school visits with an interactive programme open to secondary schools in the EU and themed visits upon request. Other initiatives include 'meet the scientists' sessions, dedicated experiments in the Ispra 'makerspace' (see section on Knowledge management) with 'do-it-yourself' activities fostering critical thinking and evidence-analysis experiments, and 'design thinking' laboratories. The programme also includes hosting secondary school students for internships or shadowing. Furthermore, it carves a dedicated time slot for a yearly school day for local secondary schools (both local schools and European schools). The programme fosters the proactive engagement of young JRC researchers with students, too.

Finally, because teachers are best-in-class multipliers, we aim to foster a yearly teachers' workshop or reflection day to elicit feedback from initiatives and stimulate the co-creation of contents. Against this backdrop, schools may also come to the JRC with their own projects, enhancing the opportunities to openly collaborate.

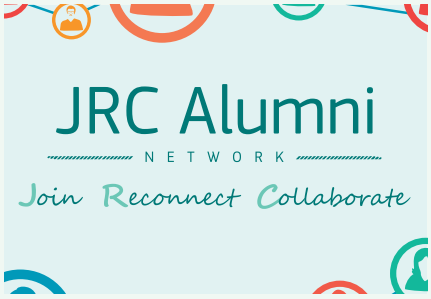
The JRC Citizen Engagement programme: giving Europeans a greater say

Political calls and commitments are increasing across the continent to enhance citizen engagement in policymaking. The EC President made a vow in her political guidelines to 'a new push for European democracy' and strengthening 'the links between people, nations and institutions', including through the conference on the future of Europe.

The JRC is fully committed to supporting the EC in this respect, and has already responded to this call with a number of initiatives, strengthening its competences and capacity to engage citizens at all stages of the policy cycle in relevant policy areas.

This endeavour is supported by a Community of Practice, extending to the whole Commission and beyond, and a growing number of collaborations among services which systematically carry out citizen engagement. These collaborations are taking place under the institutional project (ENGAGE) which aims to both extend the knowledge base used to inform policymaking and to help with tailoring and monitoring the implementation of policies in various domains.

The CoP on citizen engagement is a vibrant endeavour that seeks to organise scattered competences, build capacity, and implement and guide citizen-engagement practices at the Commission level. This is supported by a dedicated web presence and a number of events, including an annual festival, which was held in Brussels on 9-10 December 2019.



JRC Alumni Network: tailored to the needs of our alumni

The JRC's Alumni Network helps the JRC to stay in touch with former colleagues. In 2019, the community continued to grow and now has more than 500 members.

It organised the second annual JRC Alumni Network Event around the theme of 'the future of Europe', during which 42 alumni from 16 countries heard from EP representatives about dealing with and counteracting disinformation in the context of the 2019 European elections. It provided TED-talk training that was highly appreciated by participants, as well as a 'speed dating' session with current JRC experts and selected alumni.

Institutional History Project (iHiP): stories from the past that matter to Europe's present and future

The JRC's Institutional History Project (iHiP) was set up to develop a sound, official documentation of the JRC's history. The iHiP digital library is emerging, including digitally available copies of about 200 000 pages of the JRC's legacy. The iHiP Oral History Initiative is adding another perspective. The project has now collected over 30 interviews with experienced JRC staff from the past and present, who have helped to provide some 'historic highlights' – individual stories from the JRC. A team of 10 iHiP trainees conducted many of these interviews then drafted the reports and all the historic highlights.

Communication activities

The JRC's communication activities help the organisation to achieve its goals and to position it as the European Commission's science and knowledge service. Events, media outreach, social media interaction and publications all contribute to increasing the JRC's visibility and boosting its reputation with stakeholders.

Publications

A total of 4171 publications were produced:

1133
Science-for-policy, technical and training publications *

690
peer-reviewed scientific publications **

2348
other publications ***

* Science-for-policy reports; whole parts of policy documents; Science-for-policy briefs; technical reports; contribution to standards; reference materials; validated methods; reference methods and measurements; technical systems; scientific information systems and databases; datasets; training material.
** Journal contributions (Clarivate); journal contributions (Scopus).
*** Books; non-listed journal contributions; PhD theses; oral presentations; JRC-organised conference and workshop material; public information documents; external study reports; JRC contractual project management output.

Social media

In 2019, the JRC has achieved:

36.6k followers, our tweets made more than 9.8 million impressions and 33.66k interactions

19.85k followers, our posts made more than 1.24 million impressions and 9.16k interactions

49.18k followers, our posts made more than 2 million impressions and 17.51k interactions

2.38k followers, 97.04k views and 576 interactions

Events

179 events, including 70 "high level" events

Nearly 8500 participants mobilised in total

Media

100 JRC web news pieces published

Over 4393 articles mentioning the JRC

Nearly 2200 JRC newsletter subscribers

Web

Over 2.2 million visits from nearly 1.8 million unique visitors

Nearly 4.4 million page views, including over 3.4 million unique page views

A RENEWED AND COMMITTED BOARD OF GOVERNORS

The JRC Board of Governors advises the Director-General and the Commission on the strategic role of the JRC and its scientific, technical and financial management. Its members and participants bring a wealth of experience from their respective countries. As high-level representatives at the science-policy interface, former ministers, high-ranking civil servants and eminent academics from renowned universities, the Board closely engages in the JRC's activities. Receiving regular briefings from the Director-General, in turn, they give advice and inform JRC management about relevant national developments.

Where justified, dedicated ad-hoc working groups are created for more in-depth scrutiny and a better understanding by the Board as a whole. In 2019, ad-hoc working groups on the Implementation of the JRC Strategy 2030 and on Horizon Europe were active. The Senior Appointments Selection Committee also met to help the JRC to fill senior management posts. The Board of Governors met on three occasions in 2019.

117th meeting in Geel
14-15 March

The Board discussed the JRC's activities in Resilience, Fairness, Science for Policy 2.0, Enlightenment 2.0, the Second Report of the Critical Friends, Geel strategic site developments and Earth Observation in Agriculture. It endorsed the JRC's Site Development Vision 2030 and site development plans, following advice given by the ad-hoc working group on implementation of the Strategy 2030. The Board also met the JRC scientists involved in exploratory research projects and had the opportunity to visit the laboratories and facilities, including on aviation security, reference materials, and microplastics.

118th meeting in Brussels
20-21 June

The Board focused on implementation of the JRC Strategy 2030, opening research infrastructures and a training programme for Associated Countries, as well as on the JRC's work on dual-quality food products. It participated in the formal launch of the JRC flagship report on the Future of Road Transport. Following the ad-hoc working group on the Horizon Europe report, the Board adopted a report on the progress of negotiations on Horizon Europe, the Euratom proposal and decommissioning. Board members and participants actively exchanged views with Tibor Navracsics, the European Commissioner for Education, Culture, Youth and Sport, and the Director-General for Research and Innovation Jean-Eric Paquet. During the Board meeting, an election resulted in the following Board appointments: new Chair (Hervé Bernard, France), Senior Vice-Chair (Emmanuel Sinagra, Malta) and Vice-Chair (Daniel Weselka, Austria).

20th meeting in Ispra
21-22 November

The Board focused on the JRC draft budget and Work Programme 2020. It discussed thematic presentations on JRC international relations, blockchain, hybrid and cyber threats, smart specialisation, prenormative research on standards, the JRC report on demography, and the competence centre on technology transfer. The Board visited the EC's Atmospheric Observatory Tower, the Laboratory for Vehicle Market Surveillance and the European Microwave Signature Laboratory. As part of JRC activities during the Finnish Presidency to the Council of the EU, the Board welcomed young Finnish scientists to a poster session. It also met scientists involved in the JRC's exploratory research projects.

SCIENCE FOR POLICY HIGHLIGHTS

More often than not, the JRC's knowledge-production and management work is carried out in a collaborative, multidisciplinary approach. This inclusive approach imposes itself as policies – which the JRC must contribute evidence to – that are growing ever-more complex and intertwined. It also responds to the high-level political priorities that have been driving the European Commission's actions throughout President Juncker's term in office. The following chapters provide a series of examples of what the JRC has achieved in 2019 through the prism of the so-called Juncker priorities.

A new boost for jobs, growth and investment

Collective and coordinated efforts at the European level continue to be required to put Europe on the path to renewed economic prosperity. As the first of the 10 Juncker priorities, EC work in this area covers a variety of policies, a number of which the JRC contributed to in 2019.

Assisting farmers affected by drought, improving the diagnosis and treatment of rare diseases, promoting European cultural vibrancy, exploring non-power nuclear applications, tackling breast-cancer treatment inequities, and highlighting critical raw materials supply challenges are just a few examples of EC activities which were backed up with JRC expertise in 2019.

MONITORING AGRICULTURAL RESOURCES TO HELP FARMERS AFFECTED BY DROUGHT

With waves of drought afflicting Europe in 2019, the European Commission stood by affected farmers and took two decisions that complemented support mechanisms already available under the common agricultural policy (CAP).

First, farmers were able to receive a higher percentage of their direct and rural development payments in advance. Up to 70 % of their direct payments and 85 % of rural development payments were made available as of mid-October to improve their cash-flow situation.

Secondly, to be able to feed their animals, they were granted greater flexibility to use land that would normally not be used for production. Derogations from certain 'greening' requirements were granted, notably on crop diversification and ecological focus area rules on land lying fallow.

Those decisions were made possible thanks to the JRC's contribution through its data-rich expert system to monitor crop conditions, which in case of need allows for rapid assessments. For instance, for the assessment of pasture conditions across Europe, Copernicus Global Land Service products were used to assess the severity of droughts and shortages in biomass production.

The agricultural-resources monitoring work utilises a range of data sources, including meteorological data and forecasts, existing maps and statistics, positional information and remotely sensed data (from satellites and aerial sources). Within the latter, the agricultural-resources monitoring work has successfully developed operational techniques related to earth observation. Activities are based on expertise in crop modelling, agro-meteorology, sampling methods, environmental geo-spatial analysis, econometrics and the use of European and global data infrastructures.

NEW ONLINE PLATFORM IMPROVES THE DIAGNOSTIC AND TREATMENT PROSPECTS FOR RARE DISEASES

The JRC has launched a new online knowledge-sharing platform to support better diagnosis and treatment for more than 30 million Europeans living with a rare disease.

Until now, a vast amount of data on patients with specific conditions has been scattered across Europe in about 600 'registries' – databases that hold information on patients with specific conditions. Data is not collected EU-wide and there are no shared standards to analyse the information that is available on rare diseases. The new European Platform on Rare Disease Registration brings this data together, supporting the quality research that can enhance diagnosis and treatment outcomes – helping to improve the lives of patients and their families.

The platform addresses the fragmentation of rare disease data, promotes the interoperability of existing registries and helps to create new ones. It helps scientists, policymakers and patients alike make the most of data on rare diseases that have, until now, remained largely untapped. It includes a registry infrastructure comprising the European Directory of Registries, which gives an overview of each participating registry; the Central Metadata Repository, which stores all types of variables used by the registries; and a data protection tool which ensures that patients' data remains anonymous.

By providing EU standards for data collection and data sharing, the platform makes it possible to search and compare the data of patients with rare diseases. This significant achievement will allow for the creation of critical knowledge for a given disease, enabling research and support for patients, healthcare providers and policymakers.

The platform is an important asset for the European Joint Programme on Rare Diseases which aims to establish a research and innovation pipeline for the rapid translation of research results into clinical applications and uptake in healthcare. Through this programme, the platform resources can be used in future research projects and disseminated to a wider community of rare disease researchers, clinicians and patients in the EU and beyond.

SECOND EDITION OF THE CULTURAL AND CREATIVE CITIES MONITOR LAUNCHES WITH DIGITAL IMPROVEMENTS

The EC released the second edition of its Cultural and Creative Cities Monitor, a tool designed by the JRC to benchmark and boost the creative and cultural potential of European cities, which is vital to driving economic growth and social cohesion.

Following the success of the first edition in 2017, the 2019 release presented an updated portrait of Europe's cultural and creative richness in an extended sample of 190 cities in 30 countries, including Norway and Switzerland. It was accompanied by a revamped online tool which enables cities to add their own data for more in-depth coverage and benchmarking.

This second edition notably found that on a macro-regional performance level, northern Europe does best. Western Europe leads on 'cultural vibrancy', very closely followed by both northern and southern Europe. Western Europe is also the top performer on the 'creative economy', with northern Europe coming close behind. The best job-creation dynamics are found, on average, in northern and eastern European cities. For instance, jobs in the cultural and creative sectors saw an average yearly increase of around 12 % in Budapest (Hungary), Tallinn (Estonia), Vilnius (Lithuania), Krakow and Wroclaw (Poland) and Tartu (Estonia). Consistent with previous findings, leading cultural and creative cities are more prosperous: there is a positive and significant association between the Cultural and Creative Cities Index scores and cities' income levels.

Taking the concept of mapping the cultural assets of European cities one step further, a 'cultural gems' app was also launched, which provides a social sharing platform for local communities to show their hidden cultural spots, and for visitors to discover cultural and creative places off the beaten track. It

offers an easy-to-use interactive map focusing on culture and creativity and gamification aspects to engage users.

Cultural gems is free and open source: all the data contained in the app is openly reusable, aiming to provide a treasure trove of data for the cultural and creative sectors.

JRC BEST PRACTICES ON NON-POWER AND NOVEL APPLICATIONS OF NUCLEAR TECHNOLOGY

In collaboration with the University Hospital Heidelberg and the German Cancer Research Center, the JRC has developed a novel treatment for metastatic prostate cancer. The treatment enables the selective irradiation of cancer cells with alpha particles. The alpha emitter is actinium-225, linked to a peptide showing a strong affinity for the PSMA protein, overexpressed by prostate cancer cells.

Several tens of patients, who have failed all other conventional hormonal therapy, have been treated at the University Hospital Heidelberg and the University of Pretoria and Steve Biko Academic Hospital. The therapeutic responses observed showed a significant improvement in life and, in some cases, a complete response to imaging, indicating the therapy's great potential for the treatment of metastatic prostate cancer. An impressive response from prostate cancer cerebral metastases following this treatment was observed in a patient who showed a remarkable resolution of cerebral and skeletal metastases and biochemical response.

With the support of the International Atomic Energy Agency, a programme for transferring the techniques to Argentina, South Africa and Australia is now running; official clinical trials will soon start in Pretoria.

The sustainability of the production of medical radioisotopes poses challenges in the medium to long term. The EU Council requested that the medical radionuclide supply chain and clinical use in Europe was looked into. The JRC answered by launching two studies on the 'Sustainable and Resilient Supply of Medical Radioisotopes in Europe'. In addition, the JRC is participating in studies concerning novel routes for the production of radionuclides for medical applications, such as irradiation experiments, the development of targets and post-irradiation treatments.

Other examples include the development of Am-241 power sources for space exploration, through a partnership with the European Space Agency. The GELINA linear

accelerator facility has been used for applications such as archaeology, reference material characterisation, and combatting illicit traffic in drugs and explosives. The HADES underground laboratory for radioactivity measurements is crucial for environmental studies such as the effect of climate change on ocean streams.

NEW EUROPEAN RECOMMENDATIONS FOR BREAST CANCER TACKLE DISPARITIES AND INEQUITIES ACROSS EUROPE

On the occasion of breast cancer awareness month in October, the JRC presented new, evidence-based recommendations for breast cancer healthcare on a new, enhanced website of the European Commission Initiative on Breast Cancer (ECIBC). It is better tailored to people without medical knowledge and uses clear language to empower women to take informed decisions.

Recommendations include staging interventions prior to treatment, training healthcare professionals' communication skills, the optimal number of readings for radiologists in screening programmes, and inviting women to screening programmes through digital channels.

Breast cancer is the most common cancer among women in the EU. Statistics from the JRC's European Cancer Information System (ECIS) estimate more than 400 000 new cases were diagnosed in 2018. Unfortunately, great disparities and inequities persist across Europe when it comes to breast cancer prevention, early detection, care and outcomes (i.e. survival). To address this situation, the EU is spearheading many initiatives on cancer, including the ECIBC, which works to improve the quality of breast-cancer screening, diagnosis and care across Europe. ECIBC informs women and guides healthcare professionals and policymakers to plan, organise and deliver effective and accessible breast-cancer services. It notably develops and provides evidence-based recommendations and guidelines in a quality assurance scheme to facilitate implementation by breast-cancer services in EU Member States.

Not only does this help to reduce the burden of cancer, but it also helps to address the avoidable differences in breast cancer incidence, prevalence, mortality and survival, both between and within Member States.

The new website also publishes the first release of an online catalogue of trustworthy guidelines for all breast-cancer procedures after screening and diagnosis (i.e. treatment, rehabilitation, survivorship and follow-up, palliative and end-of-life care).

ADDRESSING BOTTLENECKS IN THE SUPPLY OF MATERIALS FOR EMERGING DUAL-USE TECHNOLOGIES

The JRC produced a report highlighting bottlenecks in the supply of materials critical for the emerging technologies in Europe's defence and civil (dual-use) industries.

The authors focused on five dual-use technologies: advanced batteries, fuel cells, robotics, unmanned vehicles, and 3D printing. They found that Europe is highly dependent on imports of critical raw materials (CRMs) for these technologies as only about 1 to 5 % of them come from European countries.

China already dominates global production of these CRMs. It is continuing to expand its dominant position in the Li-ion battery and drones supply chains, and has ambitious plans in the fields of robotics, fuel cells and 3D printing.

The report recommends that European policymakers introduce mitigation strategies across the whole supply chain as soon as possible. On CRMs specifically, such strategies include supply diversification, increased recycling volumes, and the substitution of critical materials. Stockpiling could be considered as a preventive measure in the event of a crisis.

Other recommended actions include creating an attractive investment environment for European companies; using synergies between the civil and defence sectors to increase interest in common research and investment opportunities; fostering international collaboration; supporting standardisation activities; and promoting the cyber physical security of robotics systems.

In addition to emerging civil/military innovations, raw materials are critical to the production of the green energy and transport technologies that contribute to achieving the EU's climate goals.

The JRC launched a new interactive tool that shows which materials we rely on, where we get them from and when demand is likely to outstrip supply. This is the case for dysprosium, a rare earth metal used for magnets in wind turbines, as well as cobalt, a key element in lithium-ion car batteries. The tool also provides information on solutions the EU can implement to mitigate the risks around critical materials, such as diversifying supply, supporting EU production, researching substitutes and promoting recycling.

GETTING SPECIFIC ABOUT NANOMATERIALS

It is the world of the infinitely small – a world invisible to the human eye. In fact, one nanometre fits in a metre a billion times. Nanomaterials are booming. They stand at the heart of a technological revolution. They have numerous benefits, including in healthcare. We also find them in many everyday products, like computers, phones, sun creams and textiles. However, as with all innovation, there are still many questions to be answered regarding their safety for human health and the environment.

The EC started to tackle this issue by explicitly addressing nanomaterials in its Regulations and by adopting a definition of nanomaterials in 2011 (the EC's Recommendation on the definition of nanomaterials (2011/696/EU)). That definition provides a general basis for regulatory instruments across many areas. However, many actors found it difficult to implement because some key concepts and terms could be interpreted in different ways. Therefore, in 2019, the JRC released two reports which will foster the correct implementation of the EC's nanomaterial definition. The JRC released its first report in February 2019 to clarify the key concepts and terms used in this definition.

In a second report on how to identify nanomaterials, published in December 2019, the JRC recommended appropriate identification methods through measurements. This is helping stakeholders to decide whether or not a material is a nanomaterial. Such a decision may carry legal consequences as nanomaterials might be subject to closer analysis of possible risks than other materials. Certain products (cosmetics, biocides, etc.) containing nanomaterials also have to be labelled accordingly. A clear classification of nanomaterials allows for the harmonised application of the relevant legal provisions in all regulatory fields and hence contributes to clearer and better regulation.

READ MORE

- **Annual Economic Report on the EU fishing fleet to support the Blue Economy**
  The 2019 Annual Economic Report on the EU Fishing Fleet shows that high levels of economic performance continue, in part due to improvements in certain fish stocks thanks to more sustainable fishing methods and management.
  https://europa.eu/!tc99pM

- **New online monitoring tool on active ageing**
  The JRC developed an online monitoring tool, the Active Ageing Index, which measures the level to which older people live independent lives, participate in paid employment and social activities, and their capacity to age actively
  https://europa.eu/!Hu83VN

- **Measuring innovation for economic and social development**
  For the ninth consecutive year, the JRC provided an independent statistical assessment of the Global Innovation Index (GII) calculations to guarantee the transparency and reliability of the index for policymakers and other stakeholders.
  https://europa.eu/!KT64rj

- **Mapping Europe's invasive species**
  The JRC mapped the geographic distribution of invasive alien species (IAS) of concern to the EU. The initiative aims inter alia to foster Member State cooperation and coordination, across borders or within shared biogeographical regions.
  https://europa.eu/!HQ83tc

- **EU Industrial R&D Investment Scoreboards for Green Deal and advanced technologies**
  The 2019 Scoreboard assesses the technological potential of European companies in the global context of green patents. EU companies show comparative advantages in most green technologies, except for ICT applications for energy.
  https://iri.jrc.ec.europa.eu/scoreboard

A connected digital single market

The Digital Single Market Strategy was the most prolific of the Juncker Commission's priorities: 30 legislative proposals were put forward. At the end of the mandate, 28 of these had been agreed upon by the co-legislature, taking Europe closer to providing its citizens and companies with the best possible access to the online world and the skills to build a digital future for Europe.

The JRC is supporting the Commission in shaping and implementing these initiatives which aim to ensure that Europe's economy, industry and society take full advantage of what digitisation has to offer. Boosting digital literacy in education, fostering biometrics identification capabilities, empowering smart technologies to improve road safety, and promoting cybersecurity cooperation and innovation are just some of the many activities the JRC pursued in 2019. Finally, if data is the new oil, then artificial intelligence is the engine of the digital transformation of economy and society. The JRC has also been very active in providing independent scientific inputs to EU policies in this area.

TEACHING AND LEARNING IN THE DIGITAL AGE: SELFIE ONE YEAR ON

SELFIE (Self-reflection on Effective Learning by Fostering the use of Innovative Educational Technologies) is the EC's free online tool that helps schools to assess and improve the ways they use technology for teaching and learning. By the end of 2019, one year after its launch, nearly 500 000 students, teachers and school leaders in 45 countries had used the JRC-developed tool.

Funded through the Erasmus+ programme, SELFIE gathers – anonymously and on a voluntary basis – the views of students, teachers and school leaders on how technology is used in their school. This is achieved using short statements and a simple 1-5 agreement scale. The statements cover areas such as leadership, infrastructure, teacher training and students' digital competence. The information is used to generate a report on strengths, weaknesses and potential areas for improvement, which in turn helps to initiate dialogue within the school and an action plan to improve the use of digital technologies.

SELFIE is continuously being improved through user testing and gathering feedback from schools. New features include a video guide for schools on setting up and customising the tool and the possibility of comparing results to previous SELFIE exercises within the same school.

In 2020, further support and training materials will be developed, including a Massive Open Online Course for schools on SELFIE and how its results can be used by teachers to improve teaching and learning with the support of digital technologies. A version of SELFIE for work-based vocational education and training is also due to start in early 2020.

SELFIE is one of the 11 initiatives in the Digital Education Action Plan which was adopted by the EC in January 2018 and runs until the end of 2020. The Action Plan aims to boost

digital skills in Europe and support the innovative use of digital technologies for teaching and learning. It is one of several Commission initiatives laying the foundations for a European Education Area.

THE SCIENCE AND TECHNOLOGY BEHIND SAFER LORRIES

Smart tachographs are connected to the Global Navigation Satellite System (GNSS) and enable wireless data remote access by control authorities, making the identification of potential offenders easier. From 2019, all heavy vehicles newly registered in the EU must be equipped with the device.

Speeding or sleepy drivers are among the main causes of accidents involving heavy vehicles and semi-trailers. Recording driving and rest times, as well as giving authorities the ability to check vehicles without stopping them, encourages compliance with safety rules and can provide evidence for law enforcers. EU regulations require that the tachograph components are type-approved and pass security, functionality and interoperability tests. The system security of smart tachographs protects the recorded data from manipulation.

To make sure the devices can be trusted, the JRC defined the system's security architecture. It has also set up and manages the European Root Certification Authority (ERCA) and the Laboratory for Interoperability Certification (DTLab).

The ERCA generates the 'secret codes' which authenticate the devices and encrypt the data. It also certifies national authorities' keys and manages the master keys used in equipment, such as motion sensors, early-detection receivers and on-board units. These keys guarantee the digital security of the tachograph data.

The DTLab is the only laboratory in Europe for interoperability certification. It tests tachographs thoroughly and certifies their ability to operate in the network, without which they cannot be sold in the EU. JRC scientists have also used this laboratory to define the smart tachograph and system security specifications the tachograph components must satisfy.

The JRC provided comprehensive guidance on the cryptographic security mechanisms and on the tachograph components, security tests and certificates, thereby enabling industry and authorities to be ready for the mandatory introduction of the smart tachographs.

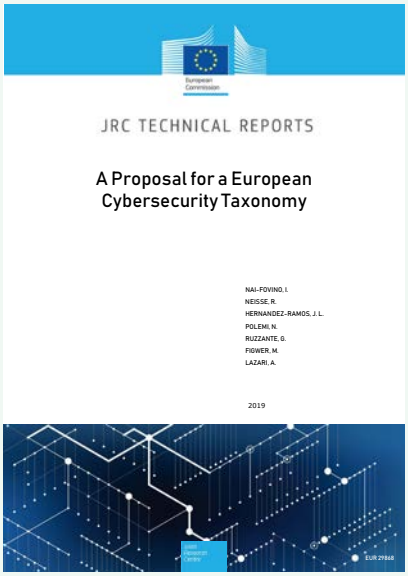
EUROPEAN TAXONOMY EMPOWERS CYBERSECURITY COOPERATION AND INNOVATION

Digital technologies are ubiquitous in our daily lives. While the opportunities they enable are plenty, so are the threats. And the more our society relies on digital technology, the higher the stakes for cybersecurity.

However, cybersecurity is not a clearly defined discipline, let alone a unified scientific field, which has somewhat hampered the pace of technical change and innovation and made it more difficult to undertake controlled experiments to advance in the field.

In an effort to address this, the JRC published a study proposing the alignment of cybersecurity terminologies, definitions and domains into a coherent and comprehensive European Cybersecurity Taxonomy. This was done in the context of the Commission's Communication on the establishment of the European Cybersecurity Industrial, Technology and Research Competence Centre and the Network of National Coordination Centres.

A reference cybersecurity taxonomy is essential to categorise EU R&D cybersecurity competencies and to increase the competitiveness of EU cybersecurity capabilities. The taxonomy proposed by the JRC supports knowledge-management activities; enables effective communication among EU institutions and the cybersecurity



community; facilitates future cooperation among cybersecurity stakeholders; and supports the governance of future EU cybersecurity initiatives.

The proposed taxonomy adopts a three-dimensional approach whereby a knowledge domain (e.g. cryptology) can be associated to a sector (e.g. health) and applied in the context of a particular technology or use cases (e.g. hardware technology).

The resulting three-dimensional taxonomy will initially be used to categorise existing EU cybersecurity competence centres (e.g. research organisations, laboratories, associations, academic institutions, groups, operational centres) according to their cybersecurity expertise in specific domains and will also be the core of the future European Cybersecurity Atlas. It could also be used in the future to classify and analyse European projects, policy initiatives and more.

BIOMETRICS AND THE SCHENGEN INFORMATION SYSTEM: FOSTERING IDENTIFICATION CAPABILITIES

To support the implementation of the EU's 2018 Schengen Information System (SIS) legislative reform, the JRC presented its recommendations for the successful implementation of facial, fingermark and DNA recognition technologies whilst also introducing stronger data-protection rules, in line with the General Data Protection Reform.

The new technologies are helping border guards to better monitor who is crossing the EU's borders, supporting police and law enforcement in capturing criminals and terrorists, and providing greater protection for missing children and vulnerable adults, in line with the EU's upgraded data protection rules.

The recommendations are meant to enable the already most-widely-used EU information system to become even more efficient, thereby making Europe a safer place for its citizens. They also support the implementation of the framework for interoperability between EU police and judicial cooperation, asylum and migration information systems.

A study on fingermark and palmmark recognition concluded that Automatic Biometric Identification Systems (ABIS) based on that technology have matured enough to integrate the SIS as long as its recommendations are implemented.

A separate study described the current state of the art for the generation and use of DNA profiles for identification purposes, including what data, metadata and format to attach to alerts in the SIS database, and the different levels of quality checks to perform before submitting DNA profiles to it.

A third study explored facial-recognition technology, and the important improvements that have occurred in recent years.

The authors of the three reports emphasised that the quality of the biometric data stored in the SIS database needs constant monitoring to prevent any poor quality data submitted from compromising the accuracy of results.

The reports will help the EC and the European Union Agency for the Operational Management of Large-Scale IT Systems in the Area of Freedom, Security and Justice (eu-LISA) to implement these three technologies in SIS.

AI WATCH, MONITORING THE RISE AND IMPACTS OF ARTIFICIAL INTELLIGENCE ON OUR ECONOMY AND SOCIETY

In December 2018, the Commission published its Coordinated Plan on Artificial Intelligence (AI), which notably foresaw the creation of a 'Commission Knowledge Service to Monitor the development, uptake and impact of Artificial Intelligence for Europe'. The service, also known as AI Watch, is operated by the JRC and in 2019 produced a large number of analyses necessary to monitor and facilitate the implementation of the European Strategy for AI.

Among these, the analytical approach of the Techno-Economics Segment (TES) aims to offer a timely representation of an integrated and very dynamic technological domain not captured by official statistics or standard classifications. This approach, developed by the JRC and applied to AI in the context of AI Watch, provides a quantitative analysis, an overview of the AI landscape, and a deep understanding of the structure of the socio-economic system, offering useful insights for possible policy initiatives.

AI Watch also produced analyses of national AI strategies in the Member States and levels of investment into the actions foreseen in the coordinated plan for AI, in the European share of the robotics market, and in progress in AI. Furthermore, it proposed an operational definition for AI.

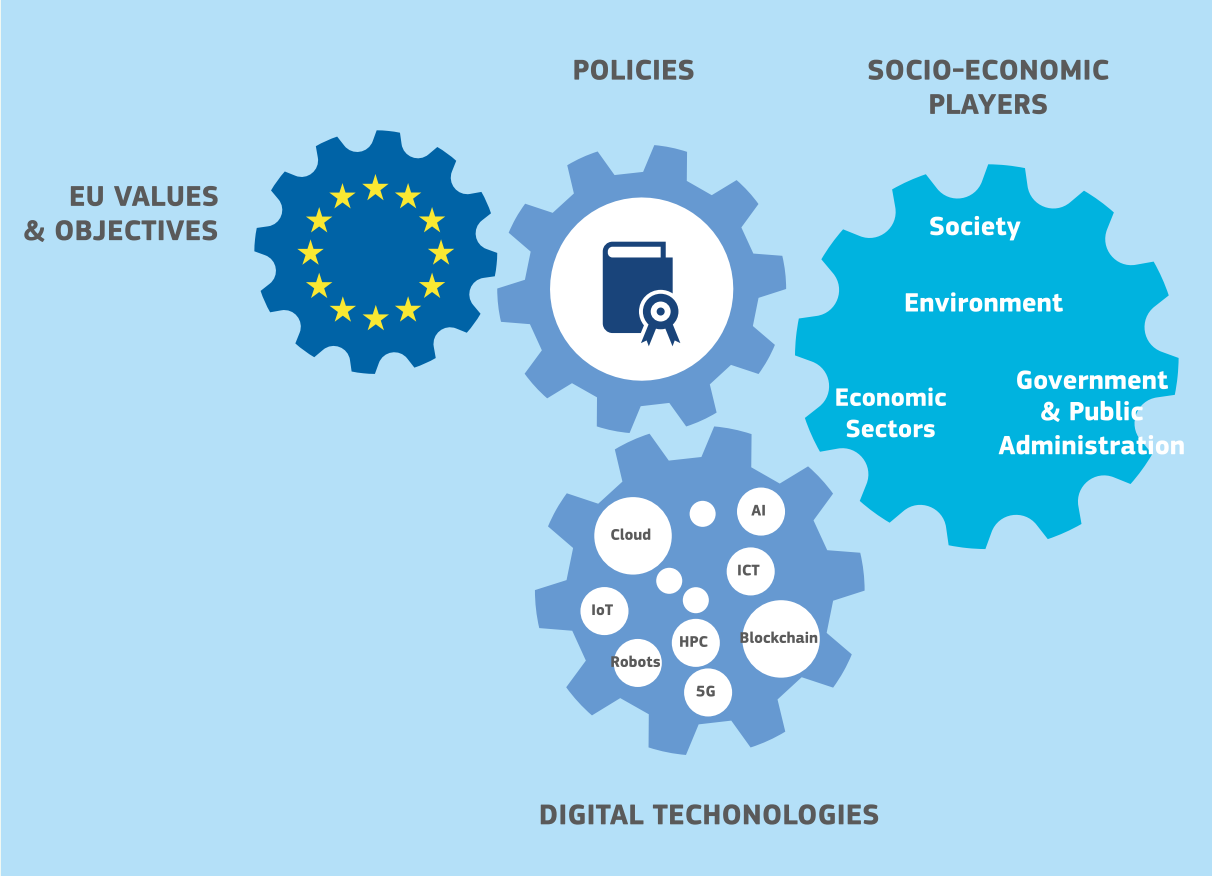
Several reports were delivered on the adoption and impact of AI in different economic sectors and key opportunities

for the public sector by adopting AI and capitalising on the excellent volume and quality of public-sector data. In addition, a study was published on technology foresight, including edge and fog computing that could change the landscape from the current dominance of cloud computing based on centralised facilities largely owned by non-Europeans.

AI Watch provided research on fairness, accountability, transparency and explainability undertaken in the context of the HUman behaviour and Machine INTelligence (HUMAINT) project run by the JRC's Centre for Advanced Studies. AI Watch also contributed to the Stanford University AI Index report 2019.

ANALYSING THE DIGITAL TRANSFORMATION IN TRANSPORT, CONSTRUCTION, ENERGY, GOVERNMENT AND PUBLIC ADMINISTRATION

There is little doubt that the impact of digital technologies on the way we live, work, communicate, and on social interaction among a growing share of the population continues to grow. The digital transformation is expected to be a strategic policy area for years to come and there is an urgent need to be able to identify and address current and future challenges, evaluate impacts and identify areas requiring policy intervention.



Proposed conceptual framework to analyse digital transformation. Source: JRC Analysis

In 2019, the JRC published a report which provided an analysis of digital transformation in transport, construction, energy, and digital government and public administration. For each of those four sectors, the report presents an overview of the digital transformation, its enablers and barriers, its economic and social impacts, and concludes with the way forward for policy and future research.

In order to address digital transformation potential and challenges systematically, the authors developed a conceptual framework that includes four main sets of interacting components: EU values and objectives, policies, digital technologies, and socio-economic players. These socio-economic players can either be impacted by or have an impact on digital transformation, or both.

The report also considered digital transformation policies either in the context of specific 'vertical' sectors – for example, transport, and digital government, or 'horizontally' – for example, in the domains of cybersecurity, data, labour, skills, etc., since many digital transformation policies have an impact on several sectors.

This simple yet comprehensive conceptual framework enabled the authors to map the dynamic landscape of digital transformation, to organise its multidisciplinary analysis around relevant topics, areas and actors, and to communicate more effectively to inform possible policy interventions.

READ MORE

- **Contributing to roadmaps on connected and automated transport**
  The JRC-run Transport Research and Innovation Monitoring and Information System (TRIMIS) supported the update of Strategic Transport Research and Innovation Agenda (STRIA) roadmaps on cooperative, connected and automated transport.
  https://europa.eu/!YP93xG

- **JRC tests conformity of eCall emergency response systems**
  The European Agency overseeing the EU Global Navigation Satellite System (GNSS) launched a testing campaign for eCall devices, inviting all device manufacturers to provide samples for conformity assessment by the JRC.
  https://europa.eu/!hy47Dx

A resilient European Energy Union with a forward-looking climate change policy

The EU's energy and climate policy aims to promote the transition towards a competitive low-carbon and resilient economy that helps to slow down global warming and mitigate its effects while ensuring affordable, secure and sustainable energy for businesses and households.

In 2019, the JRC's contributions to climate change policy covered both mitigation and adaptation efforts, notably through economic and climate modelling/assessments, monitoring and analysing emissions from different sources, helping fight nitrogen dioxide (NO_2) pollution and supporting the safe management of spent nuclear fuel and radioactive waste.

SUPPORTING THE EU'S GLOBAL LEADERSHIP IN TACKLING CLIMATE CHANGE

To limit climate change, world leaders need to know where carbon dioxide (CO_2) emissions concentrate and how emissions change over time in world regions and countries. The JRC assists the EU's global leadership in tackling climate change by providing up-to-date scientific information on global greenhouse gas (GHG) emissions.

The EDGAR database, which was built by the JRC, is one of the main sources of reference data on GHG emissions to support EU climate and energy policies. Following its 2019 update, the data includes CO_2 emissions from 1970 up to 2018 and non-CO_2 GHG emissions, namely methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (F-gases) up to 2015. A new JRC report 'Fossil CO_2 and GHG emissions for all world countries', based on the EDGAR database, confirmed the EU's leading role by showing that fossil CO_2 emissions in the EU dropped by 21.6 % compared to 1990, while total GHG emissions were 1.3 % lower. However, the report found that global CO_2 emissions are still increasing. Compared to 2017, emissions increased by 1.9 % in 2018, mostly driven by growing emissions in India (+7.2 %), Russia (+3.5 %), the United States (+2.9 %) and China (+1.5 %).

The World Input-Output Database (WIOD) environmental accounts database, launched by the JRC in 2019, complements the EDGAR and UNFCC databases by providing information on emissions and energy use based on the country of residence of the user/emitter, and not by the country in which the emission/energy use takes place. The database shows that global CO_2 emissions grew by 43 % between 2000 and 2016. The growth came mostly from emerging economies such as China, India, Indonesia and Turkey, whilst the largest decrease was observed in the EU, particularly in countries such as Greece, Sweden, the United Kingdom, Czechia, Italy, Portugal and Belgium.

Finally, to help policymakers, the JRC-led group of forest experts has developed a new science-based approach to assess

the GHG impact of human action in the forestry sector. The new approach is based on country-specific projected baselines which will be used to measure the GHG impact of future forest activities.

SUPPORTING CLIMATE CHANGE RESILIENCE AND ADAPTATION EFFORTS

The JRC contributes to global warming adaptation efforts by assessing the impacts of climate change and equipping decision-makers with the right tools and information to prepare our societies for the upcoming changes.

A prime example of the JRC's work in this area is the PESETA projects, whereby the JRC joins forces with research groups to assess climate change impacts in the EU. In 2019, through the PESETA IV project, the JRC has deepened our understanding of climate change impacts and adaptation. PESETA IV estimated both physical and economic damages for five sectors, such as river floods, coastal floods, human health, agriculture, and energy, as well as physical damages for another six sectors, including forest fires, windstorms, and habitat loss.

Several other JRC studies stemming from the now-concluded PESETA III project also examined the impact of climate change on specific areas. One report assessed future changes in EU water resources and found that if the objectives of the Paris Agreement are not met the number of Europeans affected by water scarcity could increase from 85 to 295 million by the end of the century. Furthermore, even if the Paris limits are met, central and northern Europe will be exposed to more severe seasonal floods, while southern Europe will face water shortages with severe adverse effects on hydropower resources, agriculture and transport. A separate JRC study warned that the extreme drought conditions which affected central and northern Europe in the spring and summer of 2018 could become the norm within 25 years.

According to JRC scientists, heatwaves will hit developing countries the worst. A study found that populations in developing countries will be exposed to greater levels of heatwave hazard in the 1.5 °C warming scenario than populations in developed countries would be under the 2 °C scenario. They stressed that heatwave risk could be significantly reduced for both developing and developed countries if global warming can be capped below 1.5 °C.

The JRC also explored climate change resilience. A study by JRC scientists has shown that, compared to the 1980s, fatalities and economic loss from extreme climate events have dropped significantly. That being said, they still stressed the need for continued resilience build-up efforts as extreme climate events are ever-more frequent.

The JRC offered practical help, too. By developing a new forecasting methodology, JRC experts have helped to improve the precision of the Global Flood Awareness System (GloFAS) forecasts. The JRC also shared its knowledge on climate impact assessment across the globe. In 2019, one example concerned a training session held in Argentina for local authorities within the framework of the Global Covenant of Mayors for Climate and Energy.

HELPING TO FIGHT NO_2 POLLUTION IN EUROPE'S CITIES

According to the World Health Organization, air pollution is the single largest environmental health risk in Europe. In 2016, NO_2 alone was responsible for 68 000 premature deaths within the EU. Many European cities continue to regularly exceed current EU limits for NO_2.

JRC scientists have compiled an Urban NO_2 Atlas with city factsheets for 30 major European cities to help in the design of effective air-quality measures which can reduce NO_2 concentrations within European cities. The Atlas identifies the main sources of NO_2 pollution for each city examined, helping policymakers to design actions that target them.

In the 30 European cities analysed in the report, road transport was the main source of nitride oxide (NO) and NO_2 pollution, contributing an average of 47 %. The report also

shows that shares of road transport in total local NO and NO_2 emissions differ considerably across Europe. In Athens and Milan, over 70 % of emissions come from transport, while in Lisbon, where shipping emissions are high, road transport is only responsible for 20 % of NO and NO_2 pollution. A closer look at the road transport sector shows that NO and NO_2 in cities mainly originates from diesel vehicle emissions. The map below shows that, with the exception of Greece, diesel-fuelled vehicles are responsible for the bulk of road transport NO and NO_2 emissions across all EU countries.

The Urban NO_2 Atlas shows that by reducing the flow of NO2-emitting traffic, cities could lower such emissions by an average of 40 %. NO_2-emitting traffic flows can be reduced by limiting the access of highly pollutant vehicles – primarily older diesel cars – to inner areas of cities. In the Atlas, JRC scientists provide a detailed account of the sources of NO_2 pollution for each of the 30 European cities analysed to help local policymakers to target their traffic measures.

SUPPORT TO THE RISK PREPAREDNESS REGULATION IN THE ELECTRICITY SECTOR

The EU's electricity sector is undergoing a profound transformation, characterised by more decentralised markets with more players, a higher proportion of energy from renewable sources, and more interconnected systems. Regulation 2019/941 on risk preparedness in the electricity sector provides an EU-wide framework in case of a major electricity supply crisis in this complex context, which often is not restricted to one Member State.

Articles 5 and 8 of the Regulation mention that ENTSO-E (the European Network of Transmission System Operators for Electricity) will develop a methodology for identification of electricity crisis scenarios at a regional level and a methodology for identification of seasonal and short-term adequacy assessments. During 2019, the JRC worked with DG ENER, ENTSO-E, regional coordination centres and ACER (the Agency for the Cooperation of Energy Regulators) to review the different versions of the methodologies prepared by ENTSO-E.

Thanks to JRC support, the methodologies have improved significantly and were developed on time. Finally, the JRC supported ACER in the approval procedure. The JRC drafted, in its entirety, the initial version of the 'Guidance on the key elements of the fair compensation and other key elements to be included in the technical, legal and financial arrangements between Member States for the application of the assistance mechanism under Article 15 of Regulation (EU) 2019/941 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC'.

The JRC helped to ensure that the EU has proper methodologies to assess and continuously monitor the electricity system. The final goal is to have a resilient electricity system and to be prepared and ready to deal with any potential crises.

CONTRIBUTING TO ASSESSING THE NATIONAL ENERGY AND CLIMATE PLANS SUBMITTED BY MEMBER STATES

Under the Regulation (EU)2018/1999 on the Governance of the Energy Union and Climate Action, Member States had to submit draft national energy and climate plans (NECPs) for the period 2021-2030 to the Commission by 31 December 2018. These were analysed by the EC with an overall assessment and country-specific recommendations published in June 2019. The national energy and climate plans (NECPs) are the first-ever integrated mid-term planning tools that Member States are required to prepare in view of achieving the Energy Union objectives and towards implementation of the European Green Deal.

The JRC worked with DG ENER on the review of the research, innovation and competitiveness and energy efficiency aspects of the draft NECPs. In particular, it carried out a compliance check, a robustness check of the data, and an assessment of the assumptions made in the drafts allowing for the evaluation of targets, policies and measures.

The JRC review of the draft NECPs helped Member States to identify shortcomings in their plans, which will eventually lead to improved final NECPs. JRC contributions to research and innovation, as well as energy efficiency, are included in the following communication: 'COM(2019) 285 final - United in delivering the Energy Union and Climate Action - Setting the foundations for a successful clean energy transition'. For example, the JRC reviewed how the SET Plan is translated into national objectives and measures for research and innovation. JRC inputs have been used in each of the 28 Commission Recommendations (C/2019/4401 to C/2019/4428).

Through this work, the JRC has helped to provide the framework for Member States to set long-term ambitions for research, innovation and for energy efficiency.

The setting of competitiveness objectives is an integral part of national growth strategies.

ENERGY POVERTY THROUGH THE LENS OF EU RESEARCH AND INNOVATION PROJECTS

Over 50 million people in the EU experienced energy poverty in 2018. Energy poverty means that people or households cannot afford to adequately heat their homes or use other essential energy services. The extent and seriousness of the problem have attracted significant attention, and the EU has been funding research and innovation projects to test the effectiveness of various approaches to fight energy poverty.

JRC experts analysed 31 such projects in 30 European countries (EU28 + Norway, Serbia and North-Macedonia). *Digital technologies projects* use information and communications technology (ICT) to reduce energy consumption in households at risk of energy poverty, mainly in social housing complexes. *Behavioural change* projects provide tailored advice through home visits by an energy adviser or ambassador. Financing projects address the legal and financial barriers to improve the energy efficiency of existing buildings. *Sharing of best practices* projects, research and promote tailored solutions to address the technological, social and financial barriers hindering the energy retrofit of social housing in Europe.

The study provided recommendations for future research initiatives and pilot projects. According to the authors, more projects should focus specifically on tackling energy poverty rather than treating it as secondary to meeting energy and climate targets. They also noted that future projects should cover more geographical areas and increase the participation of under-represented countries. The target population should also be extended beyond social housing as such criteria excludes many households in real need. Key stakeholders, such as distribution system operators, utilities and technology manufacturers, should also be better engaged. Success indicators, such as property market-value increase, greater comfort, health or well-being, should be further investigated as energy and cost savings do not fully respond to energy poverty concerns. Improving information and consumer engagement would also be beneficial for greater participation and uptake of lessons learnt.

IMPLEMENTING THE DIRECTIVES ON SPENT FUEL AND RADIOACTIVE WASTE

Radioactive waste and/or spent fuel is a global concern for all Member States. Originating from activities ranging from medical applications to electric power generation, their radiological properties and potential hazard call for their safe management from generation to disposal.

The Council Directive 2011/70/Euratom establishes a Community framework for guaranteeing the responsible and safe management of spent fuel and radioactive waste and requires that Member States demonstrate that reasonable steps have been taken to assure this and to ensure that no undue burden is passed on to future generations.

To assess the correct implementation of the Directive, the JRC supported DG ENER in the preparation of a comprehensive overview of the situation in the EU in the form of a Commission report to the European Parliament and the Council (adopted on 16 December 2019).

Spent fuel and radioactive waste inventory data comprises part of the Commission report. This is key information to assess whether Member States have taken reasonable steps in their national policies and programmes concerning the safe management of such materials. The JRC is supporting DG ENER in the preparation of a transparent and comprehensive overview of Union-wide inventories, including future prospects.

Since 2015, the JRC has been working with the International Atomic Energy Agency (IAEA) and the Organisation for Economic Co-operation and Development Nuclear Energy Agency (OECD NEA) to promote the greater harmonisation of data reported in national inventories and to reduce the overall reporting burden on the member states of these organisations.

A harmonised approach will benefit all stakeholders, including the public, as the information produced will become more consistent and easier to report.

As an outcome of this initiative, in 2019, the IAEA developed the Spent Fuel and Radioactive Waste Information System (SRIS) with financial support from the EC.

READ MORE

- **iRESIST+ explores hybrid structural-plus-energy retrofitting solution**
  Researchers at the JRC are exploring novel solutions for simultaneous energy and seismic retrofitting under the iRESIST+ exploratory research programme.
  https://europa.eu/!nH77tk

- **Women travel greener but are more concerned about reliability of new transport technologies**
  Transport is not gender neutral, as is confirmed in a JRC report that looks at the role of women in transport, based on data from the EC's Transport Research and Innovation Monitoring and Information System (TRIMIS).
  https://europa.eu/!Ph66Dw

- **Enhancing Resilience of Urban Ecosystems through Green Infrastructure**
  In the framework of the EU's Biodiversity Strategy and the Green Infrastructure Strategy, the EnRoute project provides scientific knowledge on how urban ecosystems can support urban planning at different policy stages and how to help policymaking for sustainable cities.
  https://europa.eu/!BN98hQ

- **Facilitating sustainable biomass use in domestic heating in the Danube region**
  Biomass is a renewable alternative to fossil fuels, but a JRC report published in 2019 reasserts the need to find balance between the benefits and possible negative impacts the greater use of biomass might have on the environment.
  https://europa.eu/!GD44xJ

- **Upgraded research facilities to enhance nuclear safety in the EU**
  The JRC in Karlsruhe has been renovating and upgrading its infrastructure to improve further the safety and security of its installations and ensure that it remains a state-of-the-art facility.
  https://europa.eu/!cM79JR

A deeper and fairer Economic and Monetary Union

Completing the Economic and Monetary Union remains a key European Commission objective. Putting the public finances of Member States on a sound and sustainable footing is critically important for the stability and prosperity of the euro area. Completing the financial union is equally important. Likewise, ensuring fair taxation and the correct functioning of welfare systems is crucial. A well-regulated Capital Markets Union encompassing all Member States should mobilise capital in Europe and channel it to all companies – including SMEs – so that they can carry out the long-term sustainable projects that are needed to expand and create jobs.

In 2019, the JRC notably explored the relationship between trade and jobs for the EU and its Member States, supported the EU Action Plan on Sustainable Finance, helped to track the tax mismatches of giant web-based companies, and assessed the macroeconomic effects of EIB Group-supported operations.

SUPPORTING THE EU ACTION PLAN ON SUSTAINABLE FINANCE

Several unprecedented challenges, such as climate change and resource depletion, require the world to take urgent action in adopting a more sustainable economic model. To support this, in March 2018, the European Commission issued an EU Action Plan on Sustainable Finance.

The first objective of the Action Plan is to reorient capital flows towards a more sustainable economy. A key action in this respect is the development of an EU Sustainable Finance Taxonomy, i.e. a classification of environmentally sustainable economic activities. The JRC provided key scientific advice to the Technical Expert Group (TEG) on Sustainable Finance in order to identify environmentally sustainable economic activities for climate change mitigation and adaptation and develop technical screening criteria. The JRC has also started to support the extension of the taxonomy to four other environmental objectives: protection of water and marine resources, circular economy, pollution prevention, and control and promotion of healthy ecosystems. The JRC also carried out an assessment of the financial impact of EU taxonomy on European equity and bond markets.

Another action foreseen in the Action Plan is the development of standards and labels. In this respect, the JRC is carrying out the technical analysis underpinning the development of the EU Ecolabel for Financial Products. It also provided scientific support to the TEG subgroup's work on the EU Green Bond Standard, providing a number of analyses on the pricing of green bonds, the relationship between green bond issuance and environmental performance, and the use of proceeds reporting.

The Plan's second objective is to mainstream sustainability into risk management. In this respect, the JRC is working in cooperation with the European Central Bank and the European Systemic Risk Board to advance our understanding of climate-related risks to

financial stability. These studies will support decision-making with respect to the potential incorporation of sustainability in prudential requirements for financial institutions.

The third objective of the Action Plan relates to fostering transparency and long-termism in financial and economic activity. To support policymaking in this field, the JRC is providing technical input for the European Supervisory Authorities on environmental disclosures, for the development of regulatory technical standards for financial market participants on sustainability reporting.

Finally, the JRC has promoted the interaction between policymakers and the scientific community on sustainable finance, organising discussion panels and events. These include an academic conference on 'Promoting Sustainable Finance', co-organised with the TEG, a Summer School on Sustainable Finance, and a joint Workshop on Banking Regulation and Sustainability with the European Banking Authority.

RHOMOLO-EIB MODEL HIGHLIGHTS THE IMPACT OF INVESTMENT IN STRATEGIC PROJECTS

The European Fund for Strategic Investments (EFSI) is the central pillar of the Investment Plan for Europe. It is tackling the post-crisis investment gap in the EU and aims to support investment in strategic projects in all EU Member States. EFSI was launched jointly by the European Investment Bank (EIB) Group and the European Commission. Every year, policy simulations are carried out using the RHOMOLO-EIB Computable General Equilibrium (CGE) model to assess the macroeconomic effects of EIB Group-supported operations (both EFSI and non-EFSI) and of EFSI operations alone.

This model is based on RHOMOLO, developed and used by the JRC for policy impact assessment, and provides sector-specific, region-specific and time-specific simulation results. It allows a distinction to be made between the short- and long-term effects of investments and takes into account the EU's territorial specificities and the spatial interlinkages of European regions and countries. However, it does differ from RHOMOLO as it is based on loans rather than grants, which makes a difference both in terms of financial flows and in areas of engagement.

RHOMOLO-EIB is a CGE model and as such does not provide unconditional forecasts. Rather, it responds to 'what if' type questions and helps to uncover economic mechanisms triggered by certain public interventions, such as the EFSI.

In its RHOMOLO-EIB 2019 update, the JRC presented the results of the latest set of simulations quantifying the estimated macroeconomic impact on EU GDP and the employment of all EFSI-supported operations approved as of 13 June 2019. The authors observed that EFSI is making a significant contribution to job creation and growth. EIB-

JRC estimates suggest that, by 2019, it had already created more than 1 million jobs (1.7 million by 2022), with a positive contribution to GDP of 0.9 % (1.8 % by 2022) above the baseline. The results of the analysis highlight the importance of investments for jobs and economic growth.

INTRA-EUROPEAN TRADE SUPPORTS ECONOMIC GROWTH AND EMPLOYMENT

The JRC has produced a study on the employment and income impacts of intra-European trade in the EU Member States.

Following up on a second edition of EU Exports to the World: Effects on Employment, this study for intra-European trade features a series of indicators to illustrate in detail the relationship between trade and jobs for the EU as a whole and for each EU Member State. It uses the new World Input-Output Database for 2016 as its main data source. These exports include goods and services that are destined for other EU countries, independently of whether they are subsequently used to produce other goods and services for a destination outside the EU.

Among many interesting findings, the study established that EU exports to other EU countries supported 33 million jobs across Europe in 2014, 21 % more than in 2000; 37 % of these jobs were held by women. Moreover, the shares of high-skilled jobs linked to such exports have increased by more than 25 % since 2000 while jobs linked to service exports have risen from 21 % to 33 % to the detriment of those of manufacturing exports, which were reduced from 76 % to 60 %. In addition, EU exports to other EU countries generate EUR 1.9 trillion of value added in the EU.

Exports support jobs across the EU and the numbers are increasing. Since 2000, the number of jobs supported by exports to other EU countries has increased by 5.8 million. The highest increases since 2000 have been seen in Poland (1.4 million) and Germany (1.3 million) whilst in terms of the employment participation over the corresponding total employment of the national economies, Bulgaria, Slovakia, Luxembourg and Czechia reported the highest increases in the same period.

These figures highlight important positive intra-European spillover effects. Intra-European exports to Germany supported 6.8 million jobs in all other EU countries, while for France it was 3.9 million and the United Kingdom, 3 million. This is because firms providing goods and services along the supply chain also gain when their end-customer sells the final product abroad.

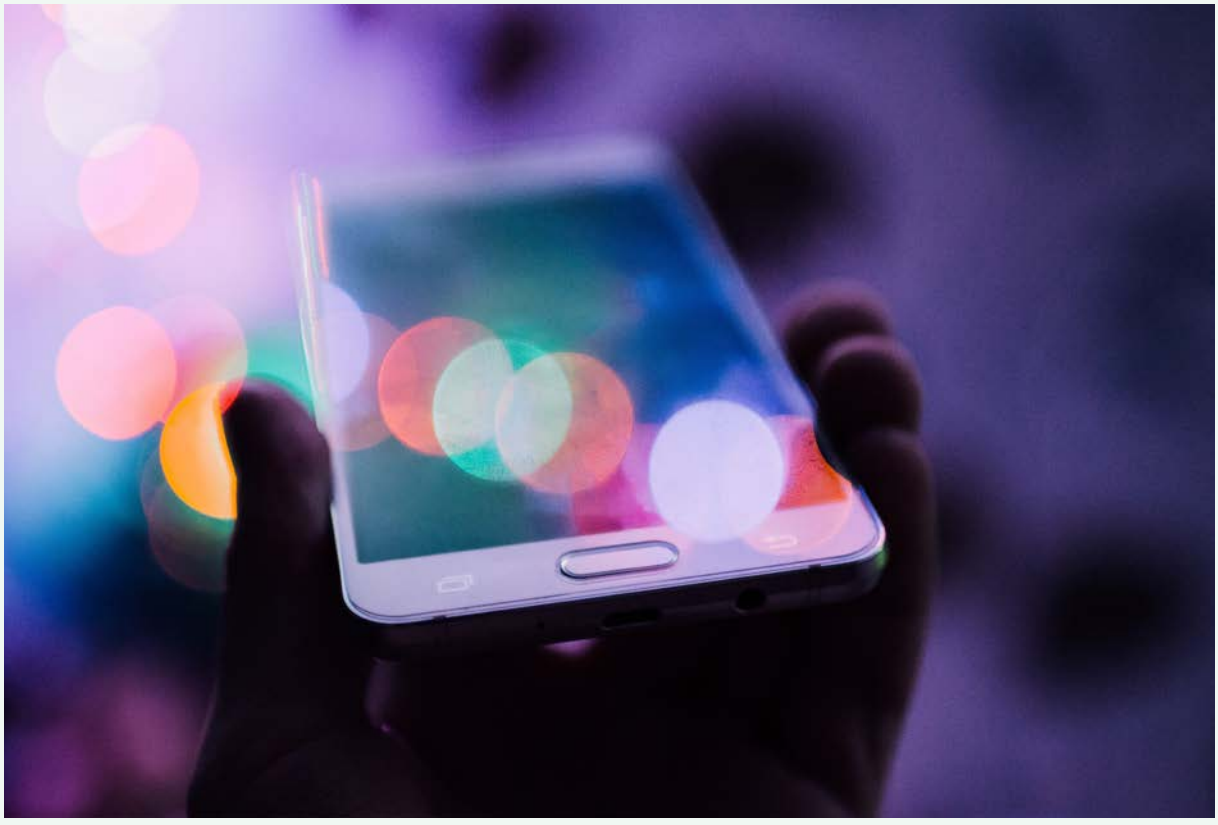
A specific JRC webpage featuring more details complemented the publication of the study.

TRACKING TAX MISMATCHES OF GIANT WEB-BASED COMPANIES

In recent years, widespread sentiment has grown about large companies, particularly those engaging in digital services, supposedly not paying their fair share of taxes. The JRC's Fiscal Policy Analysis Unit provided empirical evidence to support related work carried out by the Directorate-General for Taxation and Customs Union.

Companies that mainly operate through the web are rich in intangibles (e.g. patents, trademarks, copyrights and data) and more often than not they are not taxed in the jurisdictions where they perform significant economic activities. As intangibles are easily moved to other jurisdictions and are often unique, applying arm's-length pricing (i.e. a method to regulate intra-firm transactions based on comparison with market prices) is hard to apply in practice. Moreover, some business models exploit tracking technologies and big data for targeted advertising. Consumers collaborate (knowingly or otherwise) on the creation of value for these companies, while advertising contracts can be stipulated anywhere in the world, which also generates tax mismatches.

The JRC analysed the geographical distribution of declared financial figures (profit, turnover, fixed assets, employees) for a set of very large web-based companies and documented large mismatches between the location where value is generated and where taxes are paid. The methodology developed by the JRC can be used to track such mismatches between the place of taxation and that of economic activity.



It can also estimate potential revenue losses compared to a benchmark scenario where no such mismatches exist. The methodology can be used to estimate the impact of alternative policy reforms and to track changes over time as the tax regulation landscape evolves.

The JRC also used the computable general equilibrium model CORTAX to assess the effects of alternative policy options which are currently being discussed by the OECD. These policy proposals envisage different formulas to apportion part of the profits made by multinational groups across jurisdictions and the possibility of imposing a minimum corporate tax rate worldwide. Simulation results from CORTAX suggest a ranking of alternative reform proposals based on their predicted effects on GDP, employment, private investment, tax revenue collection and welfare, thereby providing guidance for the European institutions.

READ MORE

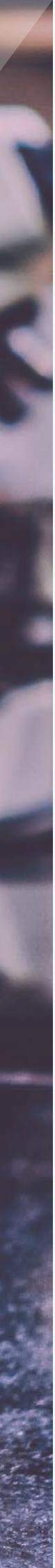
- **Multigenerational persistence of socio-economic status in the EU**
  In the context of the Fairness transversal project, a JRC policy brief explored how the transmission of socio-economic status from one generation to the next contributes to long-term inequality.
  https://europa.eu/!qj77KD

- **Monitoring progress of the European Pillar of Social Rights in EU regions**
  The regional dimension of the Social Scoreboard for the European Pillar of Social Rights was launched, highlighting the fact that focusing only on national averages does not capture the full extent of social challenges in the EU.
  https://europa.eu/!Wu44JQ

- **Incidence and determinants of loneliness across Europe**
  As part of a multi-year research project to analyse different aspects of social fairness, JRC researchers analysed the incidence and the determinants of loneliness across Europe.
  https://europa.eu/!Vc68Qd

- **Community of Practice on Fairness**
  The JRC has launched a Community of Practice on Fairness to foster an informed dialogue and knowledge sharing on the multidimensional aspects of fairness among stakeholders from the EU institutions, civil society and academia.
  https://europa.eu/!wQ37cf

A deeper and fairer internal market with a strengthened industrial base



The internal market is key to boosting growth and jobs. The areas with the highest growth potential are services, networks and the digital economy. Industry accounts for over 80 % of Europe's exports and private research and innovation and almost 25 % of jobs in the private sector. The EU's internal market policy focuses on helping to turn the EU into a smart, sustainable and inclusive economy by implementing the industrial and sectoral policies under Europe 2020.

In 2019, JRC activities which contributed to strengthening the internal market included protecting consumers against dual-quality foods; supporting police forces in training their explosives detection dogs; helping customs to detect counterfeit tobacco products and identify new psychoactive substances; setting new standards through the revision of best available techniques (BAT) reference documents; supporting the safety of nuclear installations, and more.

PREVENTING CONSUMERS FROM BEING MISLED BY INCONSISTENT FOOD PACKAGING-COMPOSITION LINK

According to EU legislation, marketing one product as identical to one marketed in another Member States although the former has a significantly different composition or characteristics which cannot be justified by legitimate and objective reasons could unfairly and illegally mislead consumers.

In response to concerns about dual-quality foods and the EC's commitment to tackling the issue, the JRC conducted a study based on a testing campaign covering 1 380 samples of 128 different food products found on the markets in 19 Member States. The products were selected based on Member States' suggestions, following complaints to consumer protection authorities or associations.

It found that in the majority of cases the composition and packaging matched: 23 % of products had an identical front-of-pack and identical composition, and 27 % signalled their different composition in different EU countries with a different front-of-pack. However, 9 % that presented as being the same across the EU had a different composition yet displayed an *identical* front-of-pack; and another 22 % had a *similar* front-of-pack but a different composition. No consistent geographical pattern emerged in the use of the same or similar packaging for products with different compositions. Moreover, the difference in composition in the products tested does not necessarily constitute a difference in product quality.

Testing was based on a harmonised methodology developed by the JRC in cooperation with Member States. This methodology allows for comparable sampling, testing and data interpretation across the EU. All EU Member States were invited to collect information regarding the composition of the selected food products offered on their markets. As a first

step, this analysis was based on information from the product labels and the front-of-pack appearance of the goods. Further steps and research are needed to make the assessment more representative, and to better understand the link between composition and quality.

JRC AND BELGIAN POLICE JOIN FORCES TO DETECT EXPLOSIVES

JRC scientists have developed a spray that can be used to train dogs to detect TATP, an explosive often used by terrorists, including in the deadliest attacks that have shaken some EU Member States in recent years.

Whether we take a flight, travel by train or attend a concert featuring our favourite band, the police and their dogs work behind the scenes to ensure our safety. Dogs must be trained, but TATP is extremely dangerous to handle making it difficult to train police dogs or to test detector devices in crowded places like airports. Before this innovation, police had to train dogs at special, highly controlled training sites, which hardly replicate the real-life conditions found in unpredictable environments such as airports and train stations. With this new TATP spray, which contains just a few milligrams of TATP, the dogs are now able to do effective training in public. The JRC worked closely with the Belgian Federal Police to develop the spray. Being in direct contact with the end-user allowed for very useful feedback cycles and the development of best practices.

The spray is also used to make sure that the swab-detection machines called ETD (explosive trace detection) at security check-ins can properly identify TATP. An ETD test kit has been developed to check that detection equipment works correctly. It was originally made for EC inspectors at the Directorate-General for Mobility and Transport, but is now used by most of the relevant authorities in EU Member States, at airports across Europe.

The JRC is currently establishing procedures to share the spray with police dog units across the EU. With the widespread use of TATP spray, there are more and more requests for similar products to detect other explosive materials. JRC scientists are currently engaging in other projects, together with the Directorate-General for Migration and Home Affairs (DG HOME), which will target detection equipment used by law enforcement, first responders and customs officers.

HELPING CUSTOMS TO DETECT COUNTERFEIT TOBACCO PRODUCTS AND IDENTIFY NEW PSYCHOACTIVE SUBSTANCES

JRC scientists have long supported customs and law-enforcement authorities in their mission to combat illicit trafficking, prevent fraud, and keep us safe. In 2019, for instance, scientists at the JRC developed a new test to tell where a cigarette has come from, and if the brand on the label corresponds to what is in the pack.

The test can help authorities to detect illicit tobacco products and trace trafficking routes. The new method has the advantage of speed and simplicity. The measurement itself, which uses a near infrared spectrometer, takes just a few minutes. The spectra obtained are stored in a database and further processed with machine-learning software to create classification models.

The spectrum of a suspicious tobacco product can then be compared with tobacco of known provenance to decide whether it is genuine or counterfeit. If a counterfeit product is detected, information can be extracted on the geographical origin of the tobacco, which can give an indication of where the illicit product may have been manufactured.

The JRC operates a dedicated laboratory facility (TOBLAB) to create chemical fingerprints, which is useful intelligence for law-enforcement agencies in EU Member States and the European Anti-Fraud Office.

Identifying new psychoactive substances (NPS) is another area where JRC expertise is in high demand.

NPS are narcotic or psychotropic drugs manufactured to mimic the effects of controlled drugs (cocaine, cannabis, heroine or amphetamines). They are of growing concern in the EU as they can cause considerable health problems by affecting the central nervous system of users that smoke, ingest, sniff or inject new substances about which very little is known.

The lack of scientific data and reference standards is making customs work incredibly difficult as officers face a large and diverse pool of chemical products that can be used as new psychoactive substances or even as precursors for new drugs.

The JRC helps the Customs Laboratories European Network (CLEN) identify unknown substances and in particular NPS, principally to facilitate the rapid identification and characterisation of seized samples, but also as a repository of analytical data and molecular identification, facilitating the interpretation of new unknown substances for future problem cases.

The JRC is also involved in the fine-tuning of on-site detection techniques that are non-contact and non-destructive to enhance the speed of the analysis and reduce the exposure to operators.

SETTING STANDARDS FOR THE WASTE-INCINERATION AND FOOD, DRINK AND MILK SECTORS

Under the JRC's leadership, experts from the EC, EU Member States, environmental organisations and industry representations have updated EU-wide environmental standards for the waste-incineration and food, drink and milk sectors. The new EU-wide emissions, monitoring and efficiency standards will help national authorities to lower the sectors' environmental impact.

The new standards were set through the revision of the Best Available Techniques (BAT) reference documents (BREFs) for waste incineration (WI) and food, drink and milk (FDM), the so-called WI and FDM BREFs. BREF documents (there are about 30 of them covering the largest agro-industrial activities in the EU) are central in lowering the environmental impact of (agro)industrial installations, as EU legislation requires about 50 000 large-scale (agro)industrial installations to hold a permit based on the use of BATs. Through its European Integrated Pollution Prevention and Control Bureau (EIPPCB), the JRC led the drafting of the new BAT conclusions on waste incineration and food, drink and milk that were finalised in 2019.

The European food, drink and milk sector represents around 290 000 companies and more than 4 million jobs in the EU in the brewing, meat-processing and sugar-manufacturing industries, among others. The new BAT conclusions for the sector reinforce the level of environmental protection, with particular emphasis on emissions to both water and air, and on energy and water consumption. The new standards also bring important improvements in terms of monitoring air emissions. The 2 800 food, drink and milk installations under the scope of the FDM BREF have 4 years to comply with these standards, although new installations must comply from the start.

The waste-incineration sector represents more than 500 installations and treats around 30 % of the EU's municipal and other types of waste, such as hazardous waste or sewage sludge. The BAT conclusions include BAT-associated emission levels that have the potential, through their translation into emission limits, to drive a sizeable reduction in emissions within the sector. The new BAT conclusions also focus on maximising water savings and reducing water pollution.

LIMITING INDUSTRIAL TRANS FATTY ACIDS IN FOOD TO PROTECT CONSUMERS IN THE EU

A new European Regulation setting a legal limit for industrially produced trans fatty acids (iTFA) came into force in May 2019. The JRC's scientific work informed and supported the EC's decision to adopt this new legislation.

A high intake of iTFA increases the risk of heart disease, the leading cause of death in the EU. This limit on their use protects the consumer and benefits public health.

The JRC performed a series of studies on the presence of trans fats in the foods and diets of the EU population, as well as on the possible impacts of different policy options aiming to reduce trans fats intake in the EU. It summarised the available data on the content of TFA in foods and on dietary intake of TFA in Europe and showed that dietary trans fatty acid intake in the EU has decreased over the last decade although not uniformly across European countries. In some European countries, the levels of iTFA in prepackaged biscuits, cakes and wafers have not dropped meaningfully since mid-2000 and some food products with high amounts of iTFA are still available on the EU market.

The JRC work also showed that a legal limit for iTFA in food would be the most cost-effective measure to reduce their intake. In April 2019, the European Commission decided to limit the amount of industrial trans fatty acids in food products to 2 grams per 100 grams of fat. Today, alternative fats and oils can replace those containing iTFA at no or minimal additional costs.

NEW STANDARD FOR SMALL PUNCH TEST SUPPORTS THE SAFETY OF NUCLEAR INSTALLATIONS AND MORE

The small punch test is a method for estimating basic material properties, such as the ultimate tensile strength (UTS) or the ductile-to-brittle transition temperature (DBTT) by means of small, disc-shaped specimens. During the test, a ball is pushed at constant velocity through the specimen and the applied force is measured as a function of the ball's position.

Small specimen test techniques have received much interest, especially for nuclear applications, because they reduce the exposure of staff to radiation, the cost of irradiation

experiments and the amount of radioactive waste. Although their development began decades ago, to date a comprehensive international standard for small punch testing is still missing.

The JRC has been at the forefront of the small punch testing method and evaluation procedures since 1990. For the past few years, it has naturally taken the lead in developing a European test standard within the framework of the European Committee for Standardization (CEN).

In 2019, the draft standard for 'Metallic materials - small punch test method' passed an important milestone by clearing the public enquiry phase with only minor, editorial comments. This means its content has been accepted by all stakeholders and the final standard will probably be published by CEN in 2020.

While the new standard provisions with regard to the test piece, the rig, and the test itself remain largely the same as in existing CEN pre-normative documents, in some cases, the recommendations in the informative annexes for data evaluation have been changed and extended quite significantly. The new standard also includes the definition of a standard data format to make the test results machine readable and will simplify the exchange of test data between different electronic systems and organisations.

Besides being used for nuclear applications, the small punch technique increasingly finds applications in other industries, such as aerospace, automotive or offshore, and for non-metallic materials like polymers or bones.

READ MORE

- **Protecting Pollinators – JRC contributes to the EU Pollinators Initiative**
  The EU Pollinators Initiative sets strategic objectives and actions to be taken by the EU and its Member States to address the decline of pollinators in the EU and to contribute to global conservation efforts.
  https://europa.eu/!Yn84VP

- **Keeping European bridges safe**
  A JRC report focused on research and innovation in bridge maintenance, inspection and monitoring in Europe in the last quarter of a century, shedding light on the future of bridge-monitoring technologies.
  https://europa.eu/!Wy46bG

- **Towards comparable results for the analysis of GMOs in the food chain**
  JRC scientists have developed a new measurement system to correctly report genetically modified content in food and feed products originating from or containing genetically modified organisms (GMOs).
  https://europa.eu/!hc36jH

- **Monitoring mineral oil hydrocarbons in food and food contact materials**
  The JRC released a guidance document on how to monitor mineral oil hydrocarbons in food and food contact materials. It covers the steps from sampling via analysis to reporting.
  https://europa.eu/!WC98xf

- **Supporting the fight against listeriosis**
  The JRC released a certified reference material (CRM) to be used as quality assurance for the analysis of Listeria monocytogenes in food-control laboratories.
  https://europa.eu/!dF94Kx

- **Prioritising the fight against 20 quarantine plant pests on EU territory**
  Following a new methodology, the JRC assessed a list of quarantine pests for their potential economic, social and environmental impact on EU agriculture and forestry.
  https://europa.eu/!Um34bn

Towards a new policy for migration

In May 2015, the European Commission presented a comprehensive European Agenda on Migration intended to address immediate challenges and equip the EU with the tools to better manage migration in the medium and long term in the areas of irregular migration, borders, asylum and legal migration. The European Agenda on Migration has guided the EU's response to immediate challenges and the work now focuses on long-term solutions to give Europe a future-proof means of managing migration responsibly and fairly.

Contributing to this Agenda, in 2019, the JRC launched its online Atlas of Migration, looked into children in migration data, co-created the new Global Transnational Mobility Dataset, and studied the specific challenges that migrants face in rural areas. The Knowledge Centre on Migration and Demography continued to be the main driving force behind many JRC initiatives relevant to the European Agenda on Migration.

NEW ONLINE ATLAS OF MIGRATION

Although a lot of data is currently available on migration and demography, it is often widely dispersed and quite complex. This means that citizens who want to understand the facts behind migration can have a hard time knowing where to look. It can also make it difficult for policymakers to base their migration policies on the best evidence.

A new edition of the Atlas of Migration was launched in December as an online guide through these complexities. Open to the public, the interactive platform allows users to create and download profiles for the countries or territories they are interested in. Because the data is updated every 24 hours, users can be confident that they are accessing the most up-to-date information available.

The information is made available by bringing together harmonised, validated data from 12 international sources. The Atlas gives information on 60 different indicators related to demography, migration, asylum, integration and development.

It shows how the composition of a Member State's population has changed in terms of citizens living in their own country (nationals), citizens from different EU countries Member States (EU mobile) and citizens from non-EU countries and territories (non-EU). The EU population increased from 511 million in January 2017 to 512 million in January 2018. In the same period, the percentages of both EU mobile citizens and non-EU citizens increased by 0.1 %. Data for each individual EU country can be accessed via the online platform.

The online Atlas is accompanied by a reference book with data on a range of migration-related fields in a format that is easy to access and understand. This provides a snapshot of migration around the world over the last year.

PROTECTING CHILDREN IN MIGRATION

There is a wealth of information available from various sources on children in migration at both the EU and international level. However, data on these children is not collected in the same way and to the same extent for all EU countries.

The new 'Data on Children in Migration' report gathered information and analyses from various sources – including Eurostat and national records – to make EU-wide estimates on the number of child migrants.

The report finds that about 7 % of children in the EU, or 6.9 million, are living in a different country from their nationality.

Just under two thirds of these – 4.3 million children – are nationals of a non-EU country. Of these, the largest numbers come from Syria, Morocco, Turkey, Afghanistan and Albania. From within the EU, the number is about 2.6 million, with Romanian and Polish the most common nationalities.

The report confirms that there is uneven spread of asylum applications across EU countries, with some countries receiving many more than others. Those EU countries dealing with the highest numbers of child asylum applications in relation to population size are Greece, Cyprus, Germany, Malta, Luxembourg, Austria and Sweden.

At the height of the migration crisis in 2015 and 2016, exceptionally high numbers of children applied for asylum in Hungary, Bulgaria and Denmark. In contrast, Italy, France and Spain are found to be consistently far below the EU average in terms of the number of asylum applications received from children. The report also finds that 16- and 17-year-olds made up 75 % of all unaccompanied migrant children in 2018.

By providing this information, experts aim to contribute to a more comprehensive information base to help national and EU policymakers manage migration in a way that provides children with the special care and assistance they are entitled to under EU and international law.

GLOBAL TRANSNATIONAL MOBILITY DATASET – NEW DATASET SHOWS GLOBAL CROSS-BORDER TRAVEL

Researchers at the EC's Knowledge Centre on Migration and Demography (KCMD) and the European University Institute Migration Policy Centre co-created the new Global Transnational Mobility Dataset by combining data on tourism and air passengers. Due to the combination of two different data sources, the dataset is more comprehensive than all pre-existing information on cross-border mobility worldwide.

Anyone can explore the data in the KCMD's Dynamic Data Hub, with an interactive map showing travel relations between countries around the globe, while raw data is provided to researchers upon request.

Based on the new dataset, researchers from the JRC and the European University Institute found that, between 2011 and 2016, cross-border mobility increased by 25 %. While for 2011, the number of estimated trips was about 2.3 billion, by 2016 it had grown to 2.9 billion. This rise is due to the increased mobility of humankind, as the relative growth of world population was much below the growth of cross-border mobility.

According to the dataset, cross-border trips within world regions are most common in Europe, followed by Asia, the Americas, Africa and Oceania. In 2016, Europe alone accounted for 1.2 billion trips within world region cross-border travel out of the global 2.9 billion cross-border mobility Intra-regional mobility between 2011 and 2016 grew most in Europe and Asia, while in the Americas there was less growth and there was almost no growth in Africa and Oceania. This suggests that instead of a catch-up, divergence is taking place over time.

Despite Africa's much larger population, transnational mobility in Europe is 20 times that of Africa. Researchers also found a strong relation between a country's outgoing trips and the national level of prosperity and pointed out that this global inequality in mobility opportunities has important sociological implications.

MIGRANTS IN RURAL AREAS FACE PARTICULAR CHALLENGES

Most of the food reaching our tables is cultivated thanks to the work of migrants, who are increasingly taking up jobs in the EU farming sector. Migrants do essential jobs in the rural areas, especially in farms that constantly need temporary workers.

This does not come without challenges. Migrants who move to rural areas face additional difficulties compared to people who choose to migrate to the EU and settle in towns and cities – due, for instance, to the temporary and often irregular nature of their work. At the same time, the situation is often challenging for the hosting society because of the lack of resources to support migrants' integration, which is also made more difficult by the remoteness of the territory.

These are the findings of the first EU-wide statistical analysis of migrants living in rural areas, carried out by the JRC, which includes both mobile EU citizens and migrants from outside the EU.

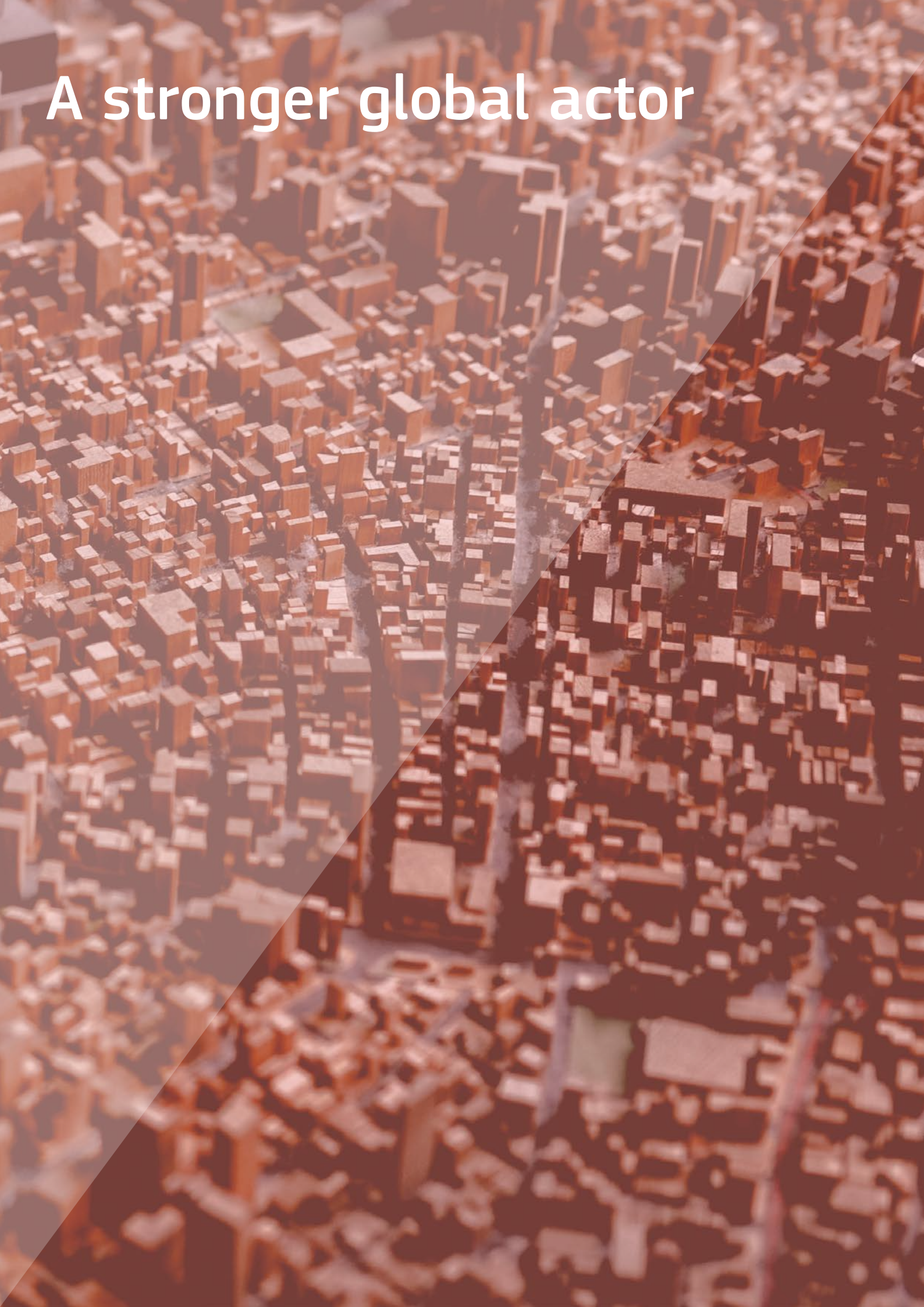
While, on average, migrants are more present in urban areas than in rural ones, their share in some rural villages and regions can be much higher than in a city. Their presence in rural areas presents both challenges (such as remoteness, isolation, limited access to services) and opportunities (contrasting depopulation trends, providing a labour force), for both migrants and the hosting communities.

The precariousness and vulnerability – coupled with the important role played by migrants in sustaining certain types of agriculture in specific regions – means migrants in rural areas require special attention when integration policies are being drawn up. By providing new evidence at the EU level, the study raised awareness at a critical moment in the ongoing negotiations and discussion on EU funds dedicated to the integration of migrants.

READ MORE

▸ **European section on IOM's Global Migration Data Portal**
A dedicated section on migration in Europe prepared by the EC's KCMD has been released on the International Organization for Migration (IOM) Global Migration Data Portal.
https://europa.eu/!JX43MQ

A stronger global actor



Today's interconnected and interdependent societies are facing unprecedented global challenges and transnational security threats, such as climate change, extreme poverty and instability. However, this also opens up new opportunities for more sustainable development, equity and peace. For Europe, it also represents the opportunity to show leadership and promote its values and vision on current and future global challenges.

To that effect, in 2019, the JRC continued to expand its forest-fire monitoring expertise on a global scale, explored global urbanisation trends through satellite imagery, provided training on securing public spaces against terrorist attacks, developed capabilities for early warning of tsunami events, investigated security risk associated with drones, and expanded international cooperation on nuclear safety with the EU and neighbouring countries.

SUPPORTING THE FIGHT AGAINST FOREST FIRES WORLDWIDE

The JRC has pioneered the development of international platforms for the assessment and monitoring of wildfires by developing the European Forest Fire Information (EFFIS), which provides citizens with information and awareness, fire managers with up-to-date wildfire information, and policymakers with science-based relevant policy data. In October 2019, EFFIS published the 'Forest Fires in Europe, Middle East and North Africa 2018' report.

Based on the experience of building the EFFIS and coordinating an international effort of currently 43 countries in Europe, the Middle East and North Africa, the JRC has embarked on developing a Global Wildfire Information System (GWIS) which will mirror the development of EFFIS in Europe to provide insights on fire regimes globally and policy relevant information on a global scale. The Emergency Response Coordinating Centre (ERCC) of the EC's Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO), the United Nations Office for Disaster Risk Reduction (UNDRR) as well as the UN's FAO are its main institutional users. The JRC leads the GWIS global initiative under the Group on Earth Observations (GEO) and is supported by the US NASA and the EU Copernicus programmes. For the first time, GWIS has recently provided national estimates on the number of fires and burnt areas. It plans to establish country profiles supporting prevention and preparedness in and capacity building supporting global initiatives, such as the Paris Agreements and the Sendai Framework agreements, contributing to the implementation of the UN's Sustainable Development Goals (SDGs).

In the context of its work in the GWIS, the JRC has launched the Global Wildfire Database which was published in the Nature Scientific Data open access scientific journal. GWIS has already provided continuous support to EC services and Cabinets on wildfire monitoring in the Amazon and the recent fires in

Australia, providing direct support to the ERCC and the Australian Government in the assessment and monitoring of, still ongoing, wildfires. The JRC is also supporting the UNDRR in work on the global assessment of wildfire risk and contributing to the next Global Assessment Report.

SUPPORTING THE MONITORING OF SDGS WITH A GLOBAL DEFINITION OF CITIES AND RURAL AREAS

The JRC turns satellite data into information on population and urbanisation and generates knowledge for use in decision-making for European and international stakeholders. This information on sustainable urbanisation will be used to better understand our transition towards a carbon-neutral Europe, and is indispensable for measuring the SDGs, understanding disaster risk and devising adaptation to a changing climate.

Until recently, understanding sustainable urbanisation had proved challenging because of the lack of adequate datasets and a commonly agreed definition to rely on. When available, data on settlements and cities covered only part of the country and often the information was not comparable across countries. The JRC used AI to extract global information on urbanisation from satellite image archives, such as the Copernicus Sentinel satellites, for international stakeholders. A consortium is currently developing a global definition of cities, urban and rural areas. The consortium includes Eurostat, the European Commission's Directorate-General for Regional and Urban Policy (DG REGIO), the JRC, the OECD, the World Bank, the UN's Food and Agriculture Organization and Human Settlements Programme and the International Labour Organization. The definition has been co-designed by DG REGIO and the JRC and is based entirely on the Global Human Settlement Layer datasets generated at the JRC. In March 2020, it was presented to the 51st UN Statistical Commission for adoption.

Preliminary analysis on global urbanisation based on this global definition of cities and rural areas is summarised in the JRC's Atlas of the Human Planet 2019. The atlas summarises 40 years of urbanisation worldwide (1975-2015) by providing 239 country urbanisation briefs, one for each country and territory in the world. Information and data presented in this policy report can be used to define regional policies, support external actions, guide development and cooperation aid, and make a key contribution to the baseline information for the 2030 Development Agenda.

HANDS-ON TRAINING TO PROTECT PUBLIC SPACES FROM TERRORIST ATTACKS

Urban planners, architects, counter-terrorism advisers and security officials from different European cities gathered at JRC Ispra for a training session organised in cooperation with DG HOME on designing and selecting solutions for protecting public spaces from terrorist attacks.

Recent terrorist attacks have shown a recurrent targeting of public spaces, exploiting the intrinsic vulnerabilities of so-called 'soft targets' that are the result of their open nature and public character, such as pedestrian precincts, tourist sites, transport hubs, shopping centres, places of worship, outdoor markets, concert halls and city squares.

The training and exchange of best practice among the participants endorsed the concept of security by design – the idea of addressing security concerns and providing physical security solutions from the very beginning of the planning and design of a public space.

With a focus on mitigating threats from ramming vehicles and explosions, the training focused on assessing the vulnerability of public spaces, developing and implementing security-awareness programmes and using modern technology, such as smartphone applications, to facilitate communication

and improve the public's reaction in case of an attack. It also explored the development of a facility or event security plan identifying the appropriate (effective, discrete, proportionate and tailor-made) measures that would not create new vulnerabilities.

Examples were given and best practices exchanged on applications in the urban layout. The training supported implementation of the Action Plan for the protection of public spaces, which is part of the EC's efforts to actively support Member States and local authorities in their fight against the threat posed by terrorism, contributing ultimately to guaranteeing the security of all European citizens.

MONITORING SUDDEN SEA-LEVEL CHANGES OFFSHORE FOR EARLY WARNING OF TSUNAMI EVENTS

A new oceanographic buoy has been positioned offshore close to La Spezia harbour in Liguria, Italy, to monitor the sea level and identify tsunami events.

The buoy has been positioned off Tino Island, in the Tyrrhenian Sea. It is part of a collaborative effort between the JRC and the Istituto Superiore per la Protezione e la Ricerca Ambientale for sea-level monitoring and the identification of tsunami events. After a testing period of eight to nine months in this location, and if the results and data acquired are satisfactory, the buoy will be repositioned in southern areas where the tsunami risk may be larger, such as the Ionian Sea or Sicily Channel.

The buoy has been instrumented by the JRC with advanced equipment that enables the centimetric estimation of the sea level, using the differential GPS technique which comprises measuring the relative height between the buoy and a fixed point on the coast (base), using GPS antennas. A software on-board also allows anomalous wave signals to be identified and for users to be informed in real time. The institution monitoring the tsunami events in Italy is the Istituto Nazionale di Geofisica e Vulcanologia but other European institutes are also interested in the levels being measured offshore.

In general, sea level is measured inside ports, along the coast. For instance, the JRC developed and installed a large network of tsunami onshore devices (inexpensive devices for sea level measurements, IDSL), distributed in the Mediterranean Sea. A new emergency early-warning system based on a similar IDSL network was also deployed in Indonesia in the aftermath of the December 2018 Krakatoa tsunami which caused more than 400 fatalities. The information collected by the JRC devices became part of the standard operating procedures of the BMKG, the Indonesian institution in charge of tsunami monitoring and alerting the entire country.

However, in the case of the above-mentioned buoy, the advantage comes from positioning it 10 to 15 kilometres from the coast, enabling it to signal an alert before the waves reach the coast. This technology is not new as it has been used in Japan for several years, but this is the first time it has been adopted in the Mediterranean Sea.

EVALUATING THE SECURITY RISK ASSOCIATED WITH DRONES

Due to their rapid technological advancements, unmanned aerial systems (UAS or drones) can satisfy to a great extent the transport needs of the modern industry, business and consumer sectors. This means that users range from military professionals to recreational users, as the number of publically available and affordable units is growing at a very high rate.

However, UAS also pose certain safety and security risks, as witnessed in recent events around airports. The use of UAS for malicious purposes is not a new concern; it has already been addressed by the EC in its Action Plan to support the protection of public spaces. ISIS has been actively using them for investigating potential targets, carrying explosive devices

and transporting weapons. UAS equipped with explosives or other malicious payloads have even been promoted through terrorist propaganda.

A recent JRC study highlighted that explosive UAS pose a particularly high threat for mass events as well as for critical infrastructures and VIPs, as security perimeters are easily breached.

The recently published UAS regulation set rules and procedures for their safe operation and used this study to shape the different UAS classes. The higher the payload of a UAS the higher the potential risk. Therefore, the safety and security measures (registration, e-identification and level of required training) imposed depend on the drone's maximum take-off mass. Further work is needed to establish testing methods for assessing UAS countermeasures, including their detection, identification and interception capabilities.

INTERNATIONAL COOPERATION IMPROVES NUCLEAR SAFETY IN THE EU AND NEIGHBOURING COUNTRIES

Continuous improvement in nuclear safety and reducing the risk of nuclear accidents in the EU's neighbourhood are important for ensuring the safety of EU citizens. Based on the comprehensive and transparent risk and safety assessments of nuclear facilities ('stress tests') performed inside the EU, world-class safety approaches have been developed. Cooperation with EU neighbouring countries operating nuclear power reactors is vital to export the EU's good practices beyond the Union's borders.

The JRC is cooperating with DG ENER and the European Nuclear Safety Regulators Group (ENSREG) to transfer EU nuclear safety approaches to the neighbouring countries.

A recent example of such cooperation is the stress test exercise in Armenia. One of the principles of the stress tests is that national nuclear regulatory authorities (NRA) carry out safety evaluations of their respective nuclear installations which are then 'peer' reviewed by other experts to ensure a unified approach. JRC experts, together with DG ENER and ENSREG, peer-reviewed the Armenian Stress Test National Action Plan. JRC reviewed the technical aspects and visited the Armenian nuclear power plant with other specialists to review the proposed safety improvements. The objective was to verify that the safety improvement measures proposed are fully in line with the stress test recommendations.

Another example is the organisation of the fifth IAEA International Conference on Effective Nuclear and Radiation Regulatory Systems: Working Together to Enhance Cooperation, which took place on 4-7 November 2019, in The Hague, Netherlands. It was hosted by the Dutch Authority for Nuclear Safety and Radiation Protection and the JRC as part of the cooperation with the IAEA. The conference focused on the role of the global nuclear regulatory community in ensuring a high standard of nuclear and radiation safety and nuclear security.

SUPPORT FOR THE INTEGRATED EU ARCTIC POLICY

The Council has been calling upon the EU to continue making a significant contribution to regional and multilateral fora dealing with Arctic matters, in light of the strategic importance of this region. In 2019, JRC expertise underpinned the integrated EU Arctic policy across its three pillars: climate change and environment, sustainable development, and international cooperation.

As regards climate change and environment, the JRC assessed the interactions between the massive retreat of sea ice and other processes, the role of permafrost degradation,

the impact of climate change on vegetation growth in boreal regions, and the changing transport of air pollutants such as black carbon. With a view to implementing sustainable development objectives, the JRC looked at Arctic marine productivity, helped in the remote sensing of the Arctic from space, and assessed the societal benefits of observing systems in the Arctic. In the context of enhancing international cooperation, the JRC has also assessed options for smart specialisation and using traditional knowledge of Arctic indigenous communities in climate adaptation.

In 2019, as in previous years, the JRC represented the EU in the group of Scientific Experts on Fish Stocks in the Central Arctic Ocean. It underpins the moratorium on fishing in the Central Arctic Ocean; is a member of the Arctic Council Expert Group on Black Carbon and Methane; is *de-facto* EU observer at the Arctic Monitoring and Assessment Programme (AMAP) and steering board member of the AMAP sponsored Sustaining Arctic Observing Networks; is *de-facto* EU observer at the Sustainable Development Working Group; is a member of the Expert Group on Marine Litter of the Protection of the Marine Environment Working Group; and collaborates with the Emergency Prevention, Preparedness and Response Working Group on marine risk assessment.

READ MORE

- **New database provides open data for over 10 000 cities worldwide**
  The JRC's new Urban Centres Database provides new open data for over 10 000 cities globally. Data analysis highlights very diverse development patterns and inequalities across cities and world regions.
  https://europa.eu/!WR96qq

- **Science4Peace portal now available**
  The Science4Peace portal is an integrated information and geospatial data platform designed to facilitate and support policy decisions. It allows users to query, analyse and combine data on situational awareness, conflict risk indicators, and real-time news feeds for early warning.
  https://europa.eu/!XC74PQ

- **Regulatory science for nanotechnology and nanoplastics**
  The JRC and the Global Coalition for Regulatory Science Research co-organised the Global Summit on Regulatory Science 2019 which focused on nanotechnology and nanoplastics.
  https://europa.eu/!Qk43gG

- **Assessing the pressure on terrestrial, marine and coastal protected areas**
  The JRC launched an updated version of its Digital Observatory for Protected Areas (DOPA) Explorer which assesses the state of and pressure on terrestrial, marine and coastal protected areas.
  https://europa.eu/!yg34ut

- **The number of people affected by food crises remains at alarming levels**
  The 2019 Global Report on Food Crises was presented jointly by the EU, the FAO, and the UN World Food Programme at a high-level event dedicated to food and agriculture in times of crisis.
  https://europa.eu/!UR63QR

BOARD OF GOVERNORS: MEMBERS AND PARTICIPANTS

(as of 31 December 2019)

Members of the Board are high-level representatives from the EU Member States, while participants represent countries associated with the Seventh Framework Programme or the subsequent Horizon 2020 Framework Programme.

Board Members are nominated by the Commission upon designation by their country's authorities. They also act as JRC ambassadors in their respective countries.

Please visit:
https://ec.europa.eu/jrc/en/about/people/board-of-governors
for an up-to-date list

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JRC ANNUAL AWARDS FOR EXCELLENCE

The JRC Annual Awards for Excellence commend outstanding work carried out at the JRC that set best practice examples in fulfilling the organisation's mission, vision and values.

In 2019, 16 Awards in 7 categories were distributed to a total of 180 staff members. ***The Science for Policy Award*** recognises exceptional support to the conception, formulation, implementation or monitoring of EU policy. ***The Knowledge Management Award*** distinguishes successful integration of new and existing knowledge from heterogeneous or multidisciplinary sources. ***The Excellence in Research Award*** acknowledges JRC scientists which research has a high impact within the scientific community. ***The Young Scientist Award*** salutes the scientific work and achievements of a young JRC scientist. ***The Innovation and/or Technical Development Award*** acknowledges distinguished support by JRC technical staff. ***The Excellence in Administration Award*** recognizes the outstanding support by JRC staff in the fields of administration, communication, human resources, financial management, information technologies, quality management, simplification, training provision, infrastructure development and maintenance, and site support services. ***The Best Team Collaboration Award*** celebrates brilliant results of team collaboration efforts.

1. SCIENCE FOR POLICY - AD HOC SUPPORT

Susana NASCIMENTO, Alexandre PÓLVORA and Joana SOUSA LOURENÇO [JRC.I.2] for ***#Blockchain4EU: Blockchain for Industrial Transformations***

1. SCIENCE FOR POLICY - LONG STANDING SUPPORT

Fulvio ARDENTE, Fabrice MATHIEUX, Silvia BOBBA, Paolo TECCHIO, Laura TALENS-PEIRO, Ignacio SANCHEZ, Laurent BESLAY, Marco RECCHIONI , Maria CALERO , Marc-Andree WOLF, Javier SANFELIX and David PENNINGTON [JRC.D.3] and for Analysis of Security and Privacy Aspects [JRC.E.3] for ***Resource Efficiency Assessment of Products (REAPro) research programme: novel methods (indicators, data, policy process and requirements) to implement and monitor circular economy requirements under Ecodesign Directive***

Giacomo GRASSI, Raul ABAD VIÑAS, Giulia FIORESE, Roberto PILLI, Matteo VIZZARI and Simone ROSSI [JRC.D.1] for ***Science-based approach for accounting climate change mitigation by EU forestry under the Paris Agreement***

1. SCIENCE FOR POLICY - LONG STANDING SUPPORT

Anna ADDAMO, Natacha CARVALHO, Hendrik DOERNER, Jean-Noël DRUON, Gianluca FIORE, Maddalena FLORIO, Maurizio GIBIN, Liselotte GREEN, Jordi GUILLEN, Ernesto JARDIM, Christoph KONRAD, Alessandro MANNINI, Jann MARTINSOHN, Iago MOSQUEIRA, Cecilia PINTO, Paris VASILAKOPOULUS and Antonella ZANZI [JRC.D.2] for ***Scientific Advice to the European Union Common Fisheries Policy***

Vangelis TZIMAS, on behalf of the 'Knowledge for the Energy Union' Unit [JRC.C.7] for ***Support to the development of an evidence-based European strategic long-term vision for a carbon-neutral economy, in partnership with the Commission's Think-Tank (EPSC) under the auspices of the Cabinet of the President***

Valerio AVITABILE, Marios AVRAAMIDES, Andrea CAMIA, Giulia FIORESE, Marco FOLLADOR, Hildegard GERLACH, Ragnar JONSSON, Leticia LANDA, Maria LUSSER, Sarah MUBAREKA, Carla PATINHA CALDEIRA, Roberto PILLI, Nicolas ROBERT, Paul ROUGIEUX, Serenella SALA, Javier SANCHEZ LOPEZ [JRC.D.1], Araujo Rita ARAUJO, Gianluca FIORE [JRC.D.2], Robert M'BAREK, Claudia PARISI, George PHILIPPIDIS, Tevecia RONZON [JRC.D.4], Marijn VAN DER VELDE [JRC.D.5], Claudia BULGHERONI and Nicolae SCARLAT [JRC.C.2] for ***Enhancing the knowledge base for 'A sustainable bioeconomy for Europe'***

2. KNOWLEDGE MANAGEMENT

Silvia MIGALI, Fabrizio NATALE, Guido TINTORI, Sona KALANTARYAN, Sara GRUBANOV-BOSKOVIC, Marco SCIPIONI, Simon MCMAHON, Thomas BARBAS, Alessandra ZAMPIERI [JRC.E.6], Rainer MÜNZ [EPSC], Fabio FARINOSI, Giovanni BIDOGLIO [JRC.D.2], Marco FOLLADOR [JRC.D.1], Cristina CATTANEO [Fondazione Enrico Mattei], Barbara BENDANDI [UNCCD Bonn] and Alessandra CONTE [JRC.A.5] for ***International Migration Drivers***

3. RESEARCH EXCELLENCE

Emanuele LUGATO [JRC.D.3] for ***JRC Soil Carbon Modelling***

Stephane CHAUDRON, Rosanna DI GIOIA and Monica GEMO [JRC.E.3] for ***Young Children (0-8) and Digital Technology***

4. YOUNG SCIENTIST AWARD

Gregory DUVEILLER [JRC.D.1] for ***Mapping the biophysical effects of vegetation cover change on climate***

5. INNOVATION & TECHNOLOGICAL DEVELOPMENT

Karin POPA [JRC.G.I.3] and Olaf WALTER [JRC.G.I.5] for ***Energy savings and radiation exposure reduction in European nuclear industry: revolutionary process for production of 2nd Generation MOX Fuel***

Akos KRISTON [JRC.C.4 previously JRC.C.1] and Andreas PFRANG [JRC.C.1] for ***Patented testing method for assessing the relationship between electrochemical and mechanical behaviour in batteries***

6. EXCELLENCE IN ADMINISTRATION

Eva MERGLOVA on behalf of the 'Financial Services' Unit [JRC.R.9] for ***Introduction of the Advanced Gateway to Meetings (AGM) corporate ICT solution at the JRC***

David EARDLEY on behalf of the 'Financial Services' Unit [JRC.R.9] for ***Qualified Electronic Signatures (QES)***

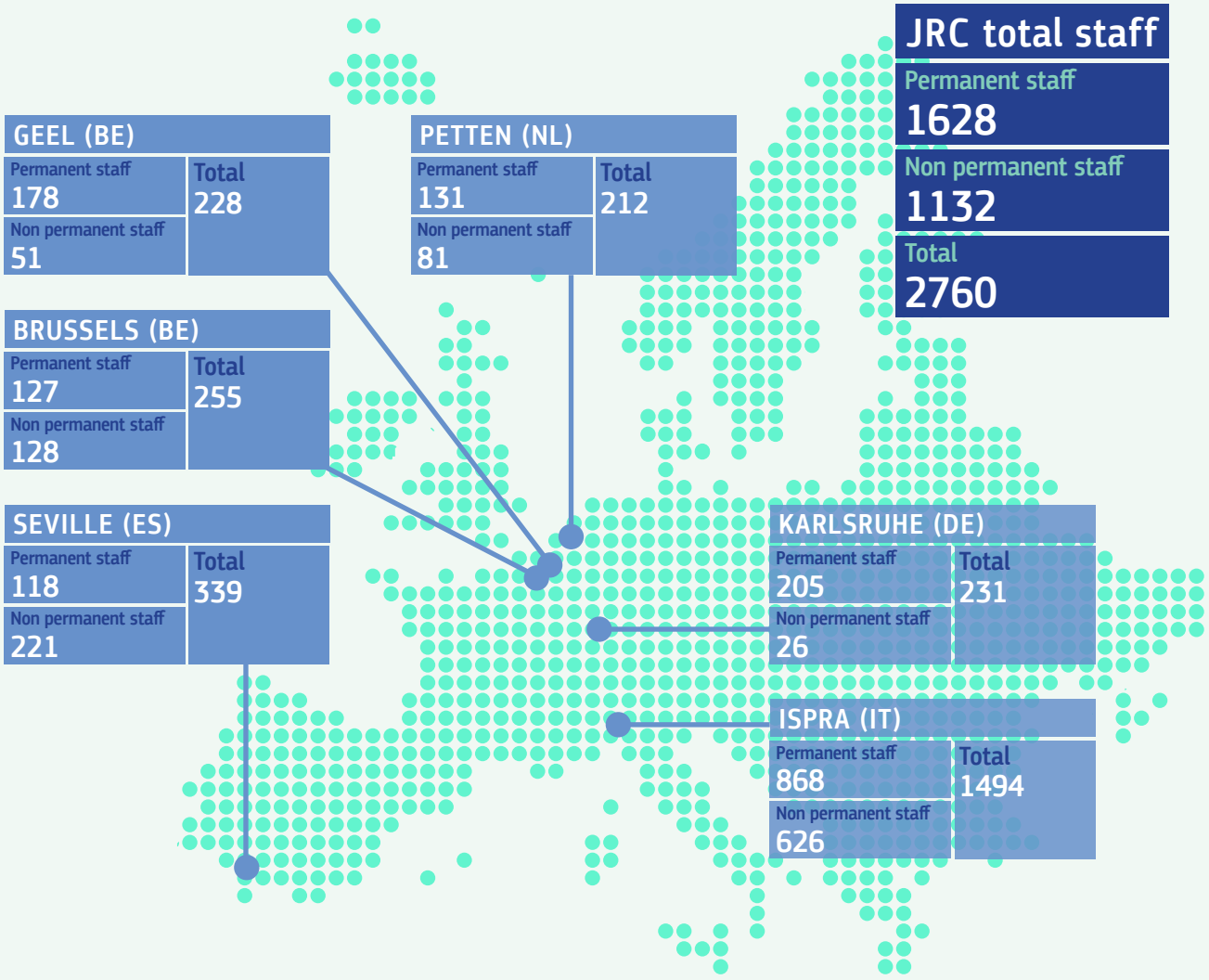
7. BEST TEAM COLLABORATION

Huy Hien BUI, Helen KEARNS, Nicola AZZARO, Elke BERGEN, Anna-Rosa PAOLINO, Cheryl Cooper [JRC.H1], Coralia CATANA [JRC.H2], Marie-Veronique LECOMTE [JRC.H1-HR.A2], Nicolas FOSTY [DIGIT.D1], Matteo MANZONETTO [HR.A2], Nora-Anda MOLNAR [DIGIT.D1], Antonella TARALLO [HR.A2], Lukas WERNERT [SG.A6], Jenia PETEVA [SG.A6] plus the One-Stop-Shop extended team comprising Sara HECTOR [HR.A1], Zachary HESTER[HR.A2], Anna IZYDORCZYK [HR.A2]; Matthieu KLEINSCHMAGER [HR.B3], Olga MURAVJOVA [HR.B3], Giovanni PALMARINI [JRC.H2], Alessandro RANCATI [JRC.I2], Conrad TOFT [HR.B3], Ludger BLASIG [HR.A2], Roberto BARCELLAN [DIGIT.D1], Stephen COLLINS [HR.A2], David MAIR [JRC.H1], Marc WILIKENS [JRC.H2], Xavier TROUSSARD [JRC.I2]; Klaus AHREND[HR.B3] and Aleksandra KULAS [SG.A6] for ***One-Stop Shop for Collaboration***

Anne-Mette JENSEN-FOREMAN [JRC.A.5] (Team Leader), Marion DEWAR [JRC.ADV03], Julia BEILE, Adrien RORIVE, Jurgita LEKAVICIUTE, Maria MALCHEVA, Agnieszka GADZINA, Jana MACHAJOVA, Ana SANTORO, Claudia SPINELLI, Marie-Agnes DELEGLISE, Jana ZIFCIAKOVA [JRC.A.2], Aurelie BOULOS, Dora DUDAS, Maren HUNDS, Stijn VERLEYEN, Elena SACHEZ, Silvia SALANSKA [JRC.A.3], Anthi CHELIOUDAKI-VARDI, Fabio TAUCER, Jerica ZUPAN [JRC.A.5], Ivana OCEANO [JRC.A.7], Tanja ACUNA [JRC.B], Elisabeth JOOSENS [JRC.B.1], Ine VANDECASTEELE [JRC.B.3], Riina VUORIKARI [JRC.B.4], Chris HUNTER, Patra KARAGOUNI [JRC.C], Jette KRAUSE, [JRC.C.4] Davide MAGAGNA, Nicola MAGNANI, Thomas TELSNIG [JRC.C.7], Marusca GNECCHI, An LIEVENS [JRC.D], Sarah MUBAREKA [JRC.D.1], Marco BERTAGLIA [JRC.D.3], Alexandra MARQUES [JRC.D.5], Aude NEUVILLE [JRC.D.6], Pierpaolo MALVINERNI, Raffaele SCHIPANI,[JRC.E], Dessi STREZOVA[JRC.E.4], Marion WESTRA [JRC.E.6], Eva AHS LOPEZ, Raffaele CORVI [JRC.F.3], Alexandre ANGERS, Nikolay DENIN [JRC.F.7], Jorge TANARRO, Elisa LONGOBARDI, Vaida RUKAITE DRAZDOVE [JRC.G.10], Laura SMILLIE, Lene TOPP [JRC.H.1], Catherine SIMONEAU, Silvia BOMBARDONE [JRC.H.2], Lorena MARCALETTI, Fabrizio BONATO [JRC.I], Valentina MONTALTO [JRC.I.1], Thierry STIEVENART [JRC.R.8] for ***The JRC Clear Writers' Network***

JRC SITES MAP AND KEY FACTS AND FIGURES

(as of 31 December 2019)



* The JRC's biggest site is Ispra, where 54 % of all active staff are located, followed by Sevilla (12 %).
** The four other sites (Brussels, Geel, Karlsruhe and Petten) have a fairly equal number of staff (approximately 8 %).

EQUAL OPPORTUNITIES

By the end of 2019, women represented 39 % of the JRC's active staff and 35 % of its administrator's (AD) function group. The JRC is making a continuous effort to meet Commission targets for female staff holding management positions.

Positions (% female)	2017	2018	2019
Senior management	45 %	42 %	50 %
Middle management	14 %	16 %	28 %
Non-management administrators (AD)	25 %	25 %	35 %

JRC CONTRACTUAL INCOME

The value of contracts signed by the JRC in 2019 amounted to EUR 78.6 million. The table below shows the split of the contracts signed by 31 December 2019. These activities complement the tasks outlined in the JRC's work programme and are essential to acquiring and transferring expertise and know-how.

Contracts signed (in million EUR)	2017	2018	2019
Indirect actions (framework programme)	10.9	7.8	4.2
Support to Commission services	99.7	66.3	68.5
Third party work	5.9	6.2	10.7
Total (rounded)	116.5	80.3	83.4

BUDGET

The JRC is funded by the EU's Framework Programme for research and innovation, currently Horizon 2020, and the EURATOM research and training programme. Further income is generated through additional work for Commission services and contract work for third parties.

The JRC's available credits are allocated to staff expenses, means of execution (maintenance of buildings and equipment, commodities, insurance, consumables, etc.) and specific expenses (direct scientific procurements) related to the research and innovation framework programme activities.

The table shows the breakdown of how the 2019 budget was spent (in terms of available commitment appropriations, EFTA not included). In addition, EUR 30.8 million was made available for the programme to decommission the JRC nuclear installations, and for EURATOM-related waste management. An additional EUR 30.7 million was received in the form of contributions from countries associated to Horizon 2020 and EEA-EFTA countries.

Outgoing expenditures (in million EUR)	2017	2018	2019
Staff expenses	237.3	237.4	244.28
Means of execution	97.2	97.2	114.45
Operational appropriations (FP) €	38.0	39.1	50.26
Total (rounded)	372.5	373.7	408.99

STAFF

The total number of active staff working at the JRC on 31 December 2019 was 2 760. Of that total, about 70 % of staff were work programme staff and 30 % support services staff. Work programme staff include core research staff and technical support staff. Support services staff include support entities and administrative support staff in scientific directorates.

European Commission

JRC - JOINT RESEARCH CENTRE
ORGANISATIONAL CHART - 16 MAY 2020

Strategy & Coordination

Director General (Brussels) Stephen QUEST

Deputy Director General (Brussels) Bernard MAGENHANN

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Principal Adviser for Life Sciences Elke ANKLAM — BRUSSELS

Adviser for Scientific Development Marion DEWAR — BRUSSELS

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- 3. Territorial Development Alessandro RAINOLDI — SEVILLE, ISPRA
- 4. Human Capital & Employment Ioannis MAGHIROS — SEVILLE, ISPRA
- 5. Circular Economy & Industrial Leadership Oliver WOLF acting — SEVILLE
- 6. Digital Economy Michael LUTZ acting — SEVILLE, ISPRA

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- 3. Energy Security, Distribution & Markets Marcelo MASERA — PETTEN, ISPRA, SEVILLE
- 4. Sustainable Transport Alois KRASENBRINK — ISPRA
- 5. Air & Climate Elisabetta VIGNATI — ISPRA
- 6. Economics of Climate Change, Energy & Transport Antonio SORIA RAMIREZ — SEVILLE, PETTEN

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- 2. Knowledge Management Methodologies, Communities and Dissemination Marc WILIKENS — ISPRA, BRUSSELS
- 7. Knowledge for Finance, Innovation & Growth Xabier GOENAGA BELDARRAIN — BRUSSELS, SEVILLE
- 7. Knowledge for Energy Union Efstathios PETEVES — PETTEN, BRUSSELS

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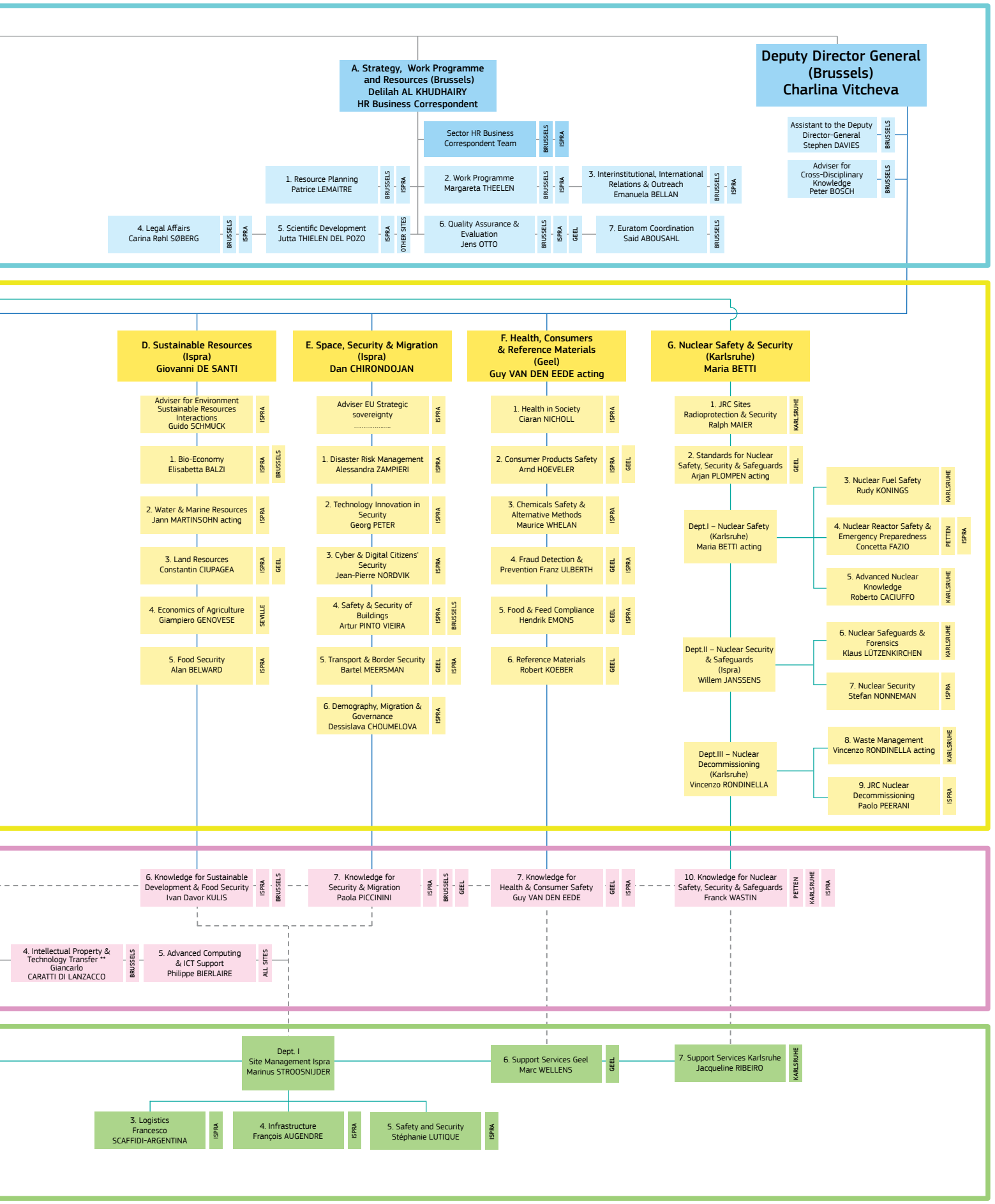
- 8. Budget Execution Stanislav DRAPAL — BRUSSELS, ISPRA
- 9. Financial Services Ian FORMOSA — ISPRA, BRUSSELS, GEEL

* Mrs Dewandre is seconded as Adviser to the President's cabinet
** includes the Central Intellectual Property Service of the European Commission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European Commission
Joint Research Centre

Annual Report 2019
Report on the activities, accomplishments and resources related to the JRC's work carried out in 2019. An overview is given of the scientific achievements and activities as well as of corporate initiatives.

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